OBLON ET AL (703) 413-3000
DOCKET # 1954674US2SPD SHEET 1 OF 28

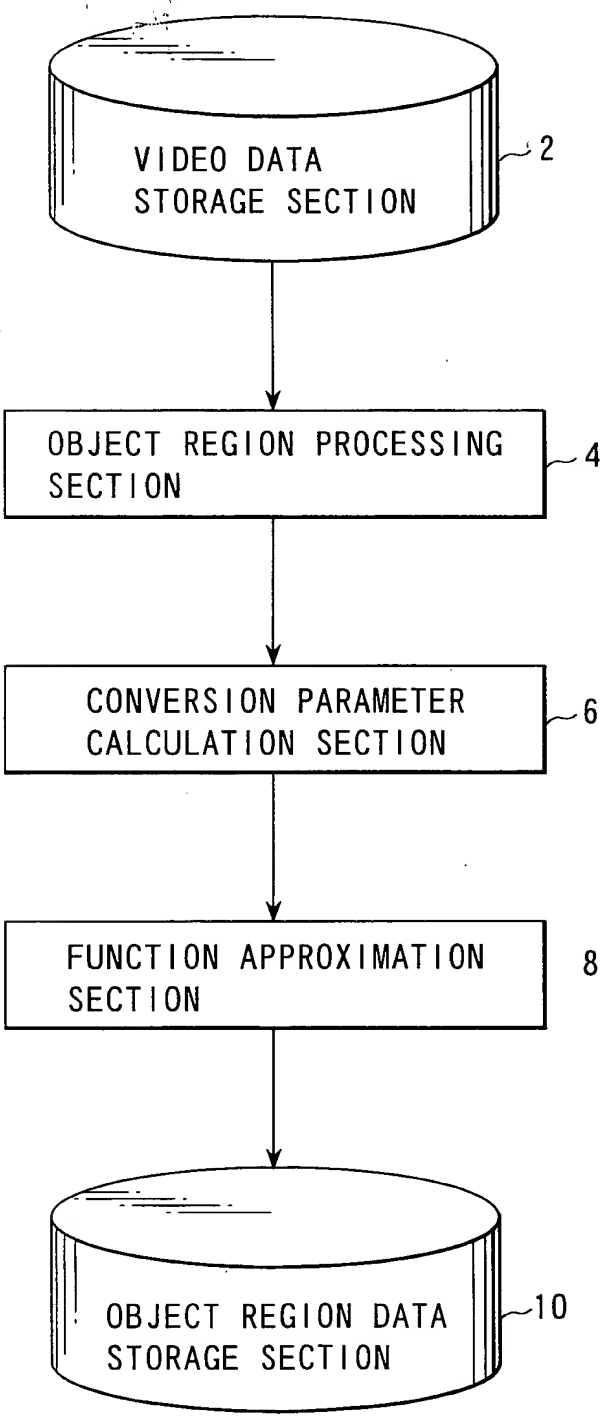


FIG. 1

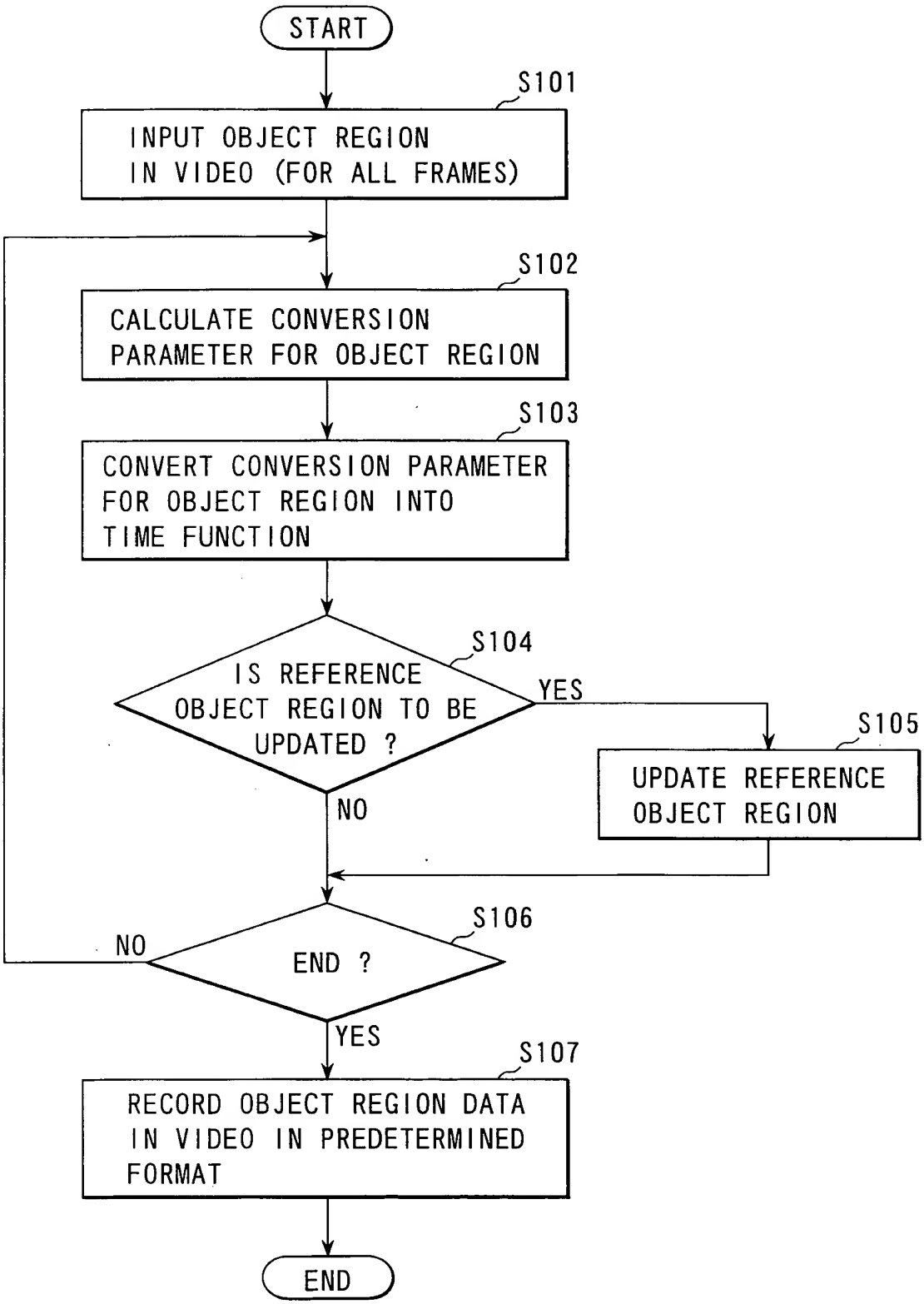

START
S101
INPUT OBJECT REGION IN VIDEO (FOR ALL FRAMES)
S102
CALCULATE CONVERSION PARAMETER FOR OBJECT REGION
S103
CONVERT CONVERSION PARAMETER FOR OBJECT REGION INTO TIME FUNCTION
S104
IS REFERENCE OBJECT REGION TO BE UPDATED ?
YES
S105
UPDATE REFERENCE OBJECT REGION
NO
S106
END ?
NO
YES
S107
RECORD OBJECT REGION DATA IN VIDEO IN PREDETERMINED FORMAT
END

FIG. 2

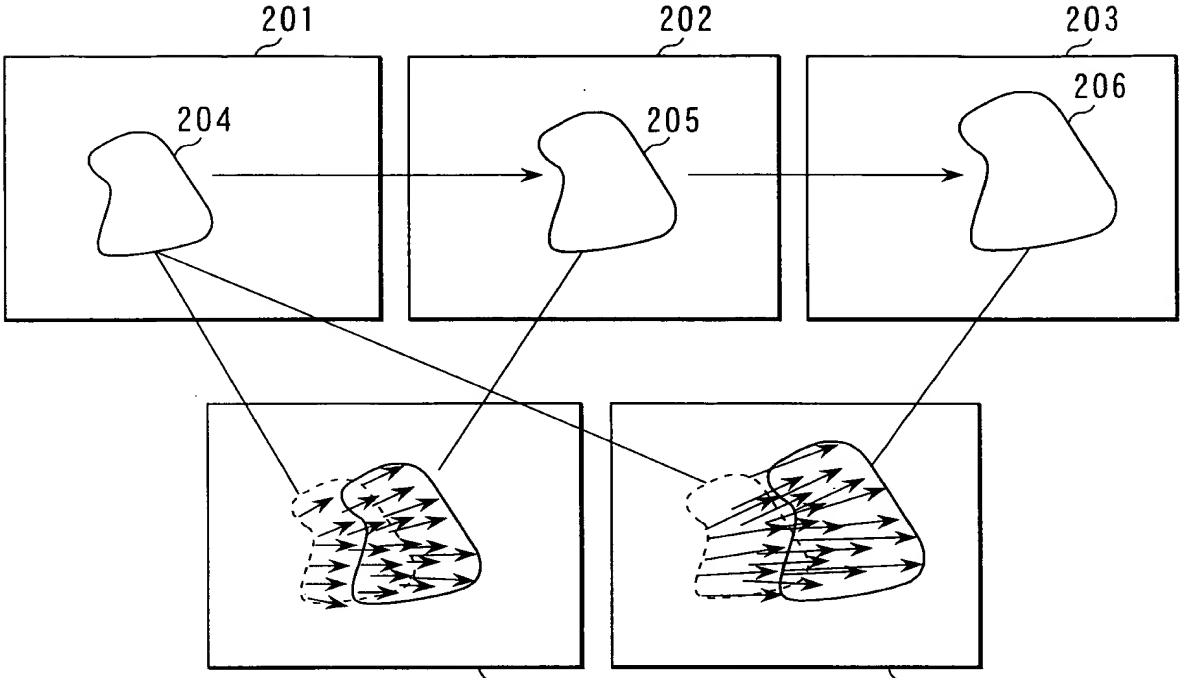


FIG. 3

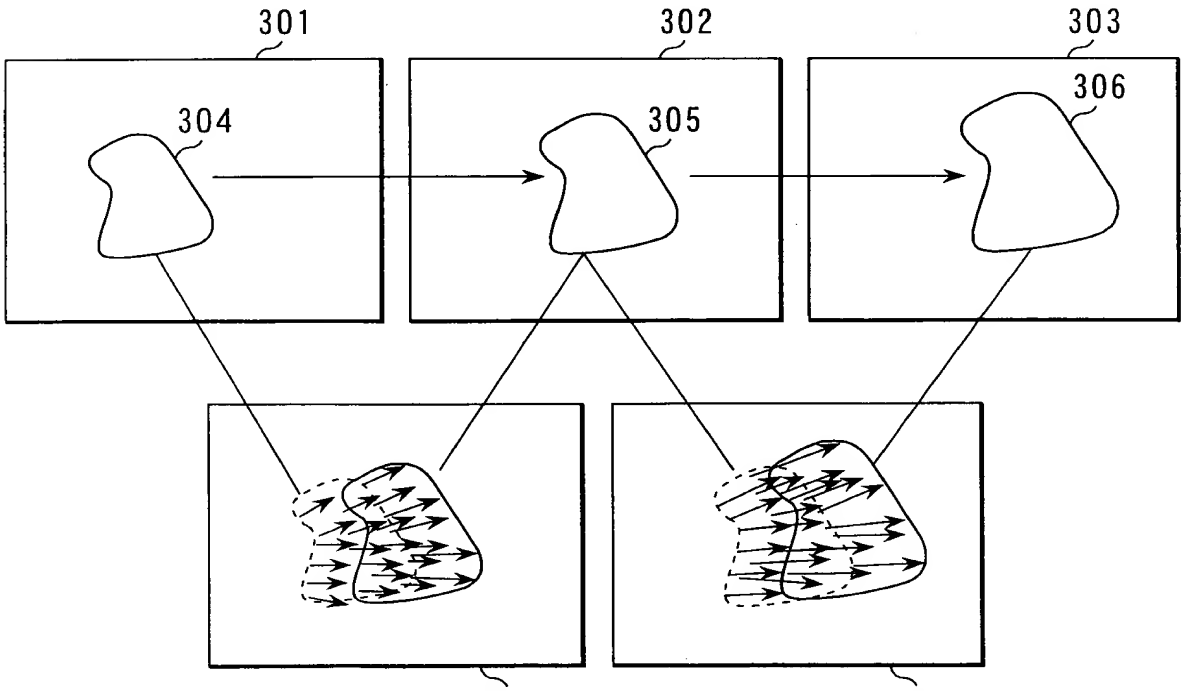


FIG. 4

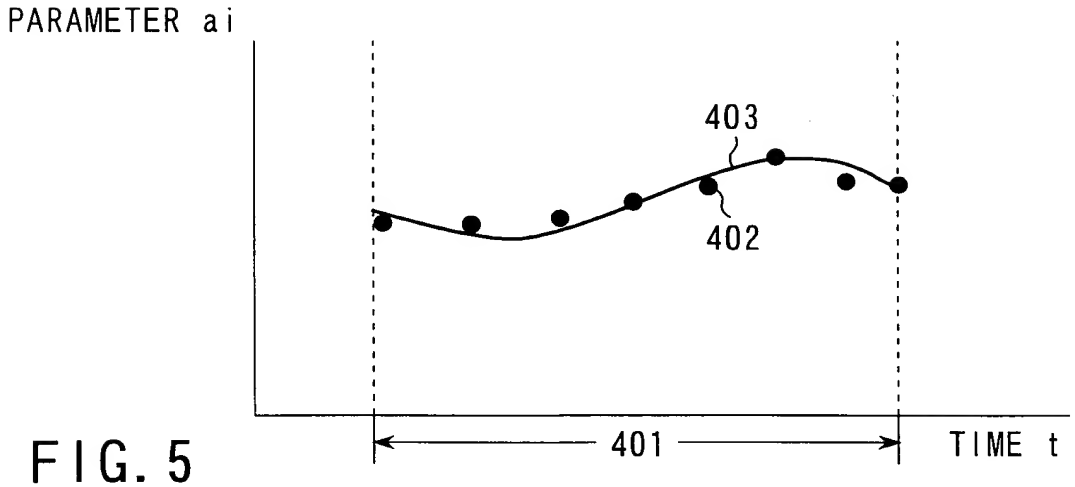

PARAMETER ai
403
402
401
TIME t

FIG. 5

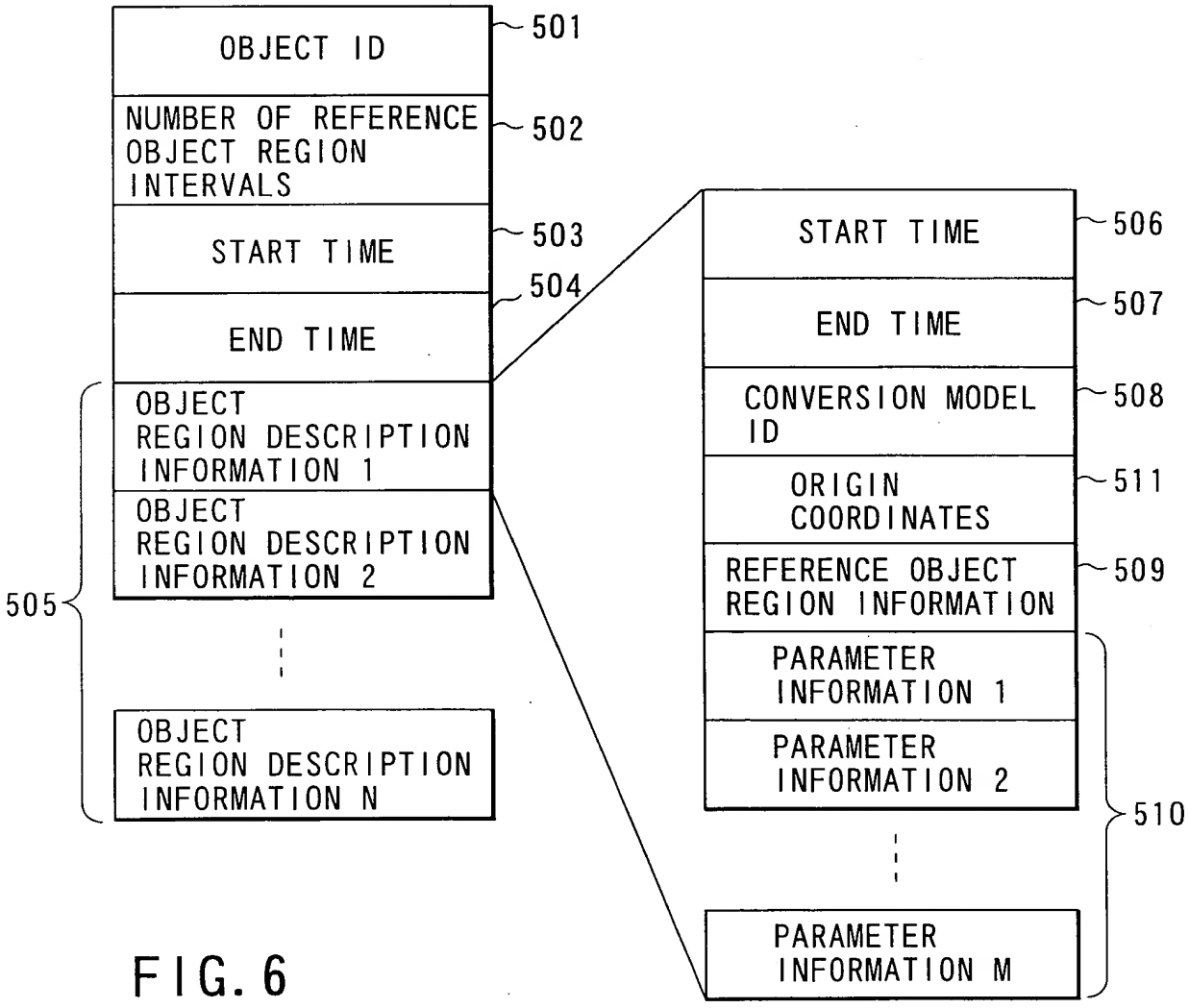

OBJECT ID
501
NUMBER OF REFERENCE OBJECT REGION INTERVALS
502
START TIME
503
END TIME
504
OBJECT REGION DESCRIPTION INFORMATION 1
OBJECT REGION DESCRIPTION INFORMATION 2
OBJECT REGION DESCRIPTION INFORMATION N
505
START TIME
506
END TIME
507
CONVERSION MODEL ID
508
ORIGIN COORDINATES
511
REFERENCE OBJECT REGION INFORMATION
509
PARAMETER INFORMATION 1
PARAMETER INFORMATION 2
PARAMETER INFORMATION M
510

FIG. 6

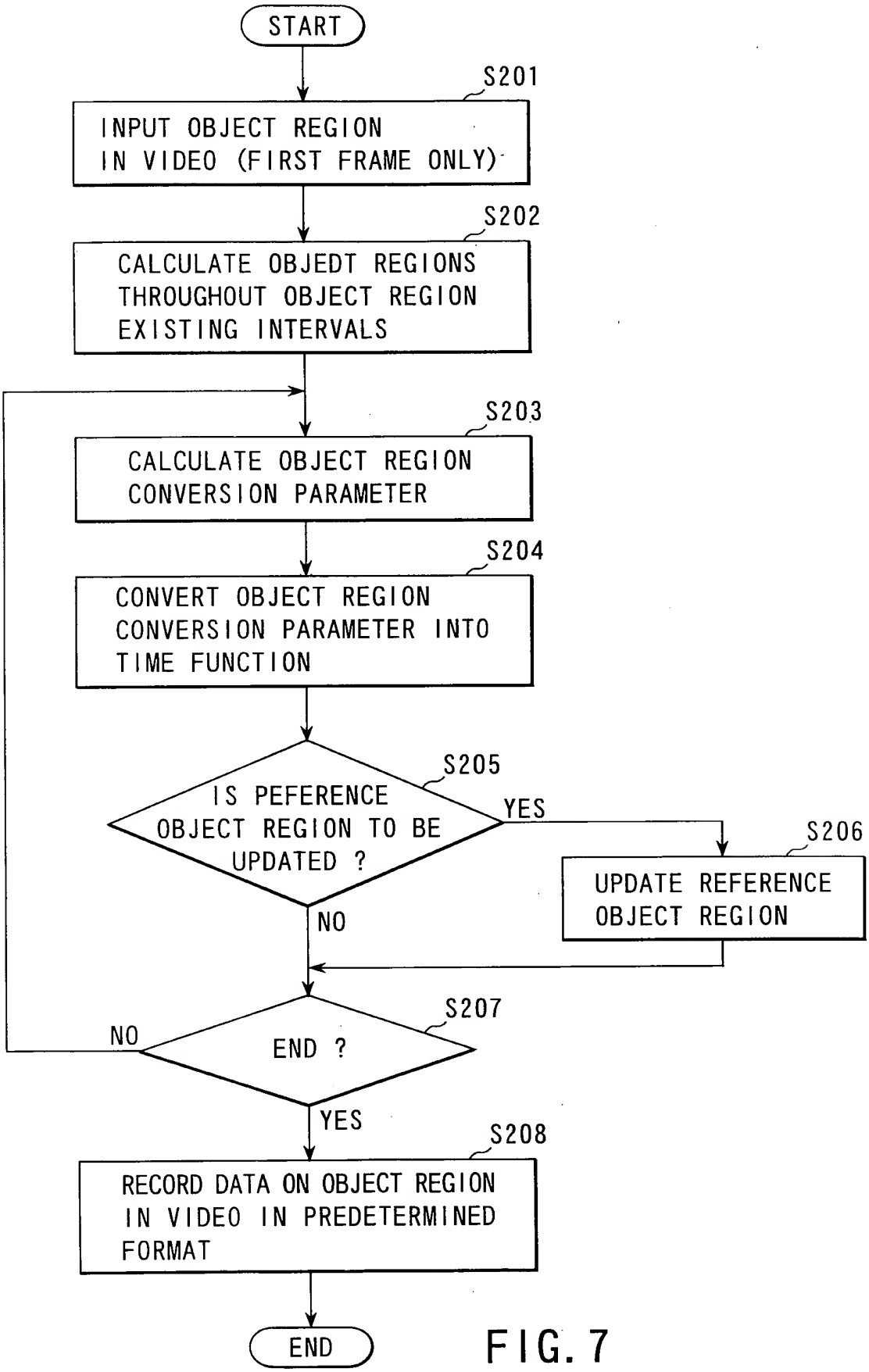


FIG. 7

Docket #19546US2SP Sheet 5 of 28

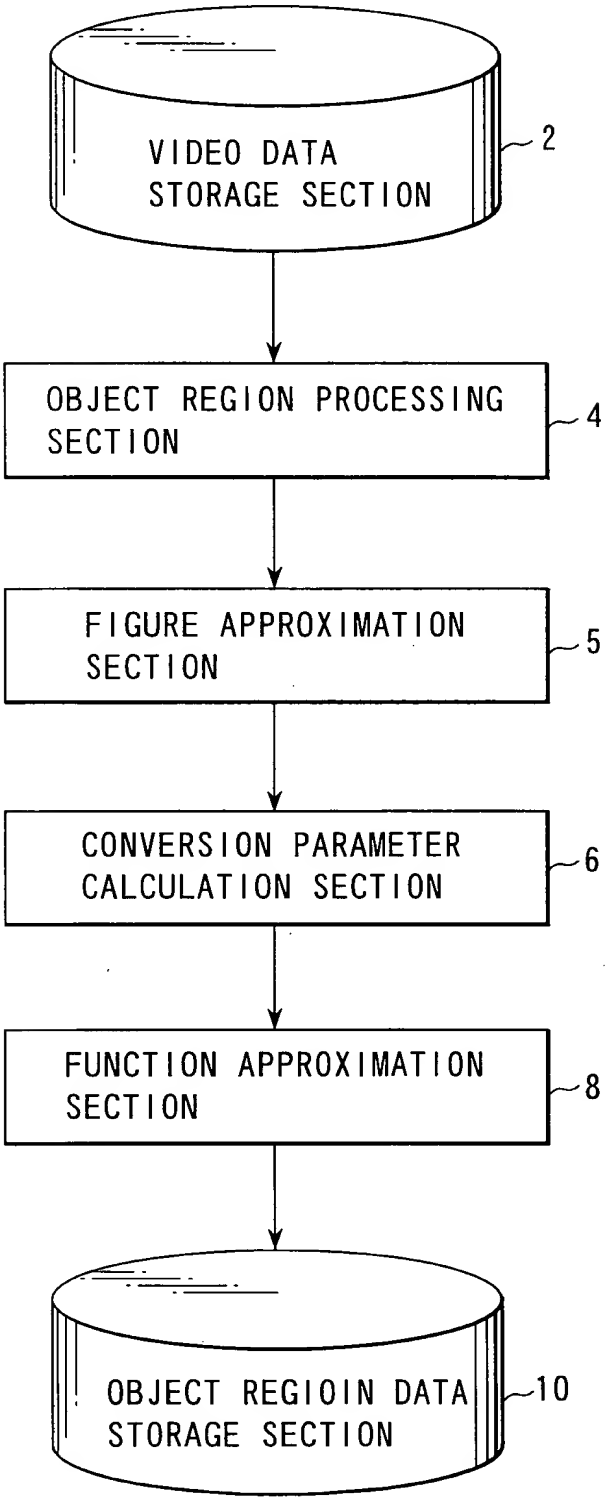

VIDEO DATA STORAGE SECTION
2
OBJECT REGION PROCESSING SECTION
4
FIGURE APPROXIMATION SECTION
5
CONVERSION PARAMETER CALCULATION SECTION
6
FUNCTION APPROXIMATION SECTION
8
OBJECT REGIOIN DATA STORAGE SECTION
10

FIG. 8

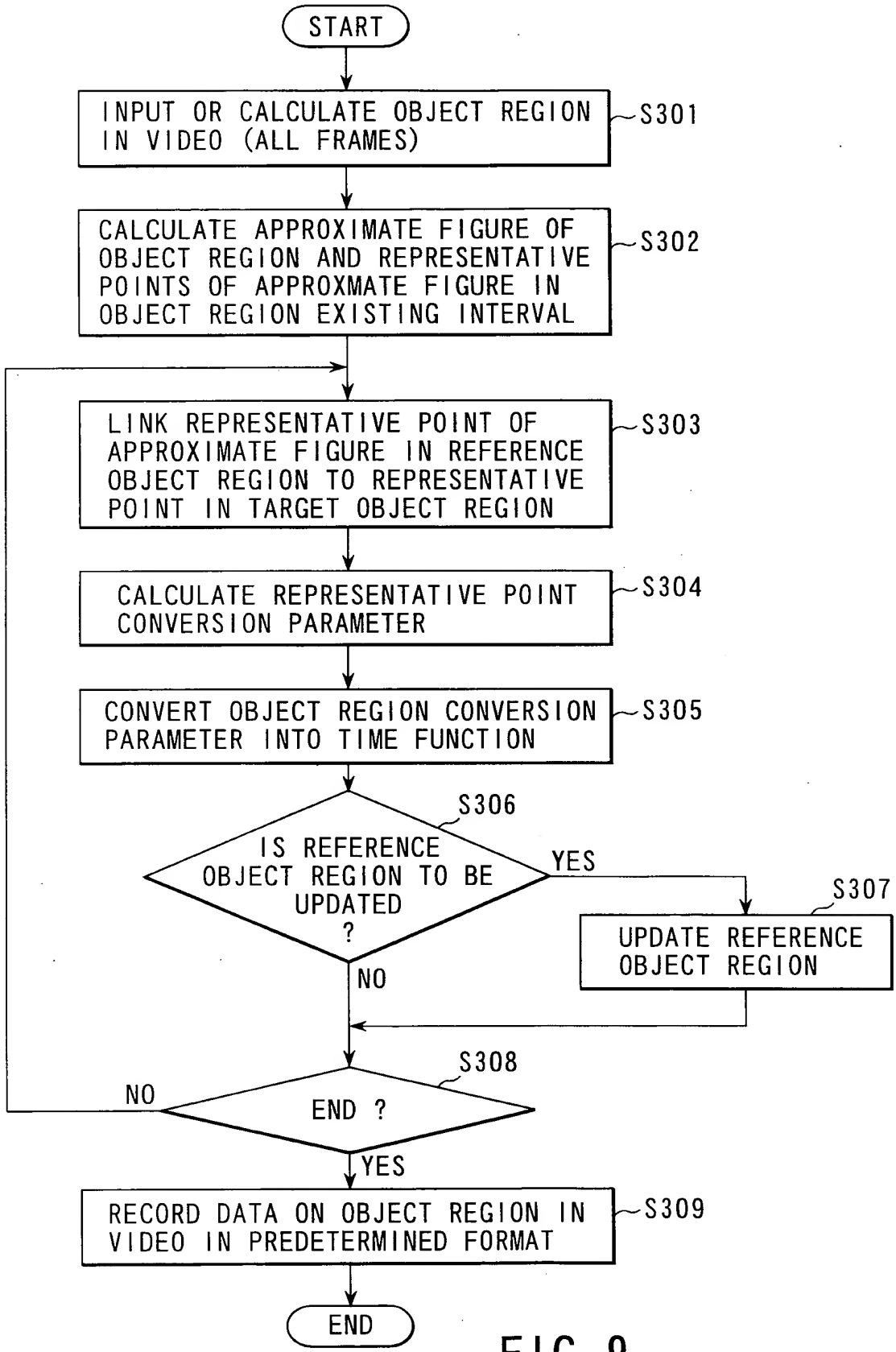

START
INPUT OR CALCULATE OBJECT REGION IN VIDEO (ALL FRAMES)
S301
CALCULATE APPROXIMATE FIGURE OF OBJECT REGION AND REPRESENTATIVE POINTS OF APPROXMATE FIGURE IN OBJECT REGION EXISTING INTERVAL
S302
LINK REPRESENTATIVE POINT OF APPROXIMATE FIGURE IN REFERENCE OBJECT REGION TO REPRESENTATIVE POINT IN TARGET OBJECT REGION
S303
CALCULATE REPRESENTATIVE POINT CONVERSION PARAMETER
S304
CONVERT OBJECT REGION CONVERSION PARAMETER INTO TIME FUNCTION
S305
S306
IS REFERENCE OBJECT REGION TO BE UPDATED ?
YES
NO
S307
UPDATE REFERENCE OBJECT REGION
S308
NO
END ?
YES
RECORD DATA ON OBJECT REGION IN VIDEO IN PREDETERMINED FORMAT
S309
END

FIG. 9

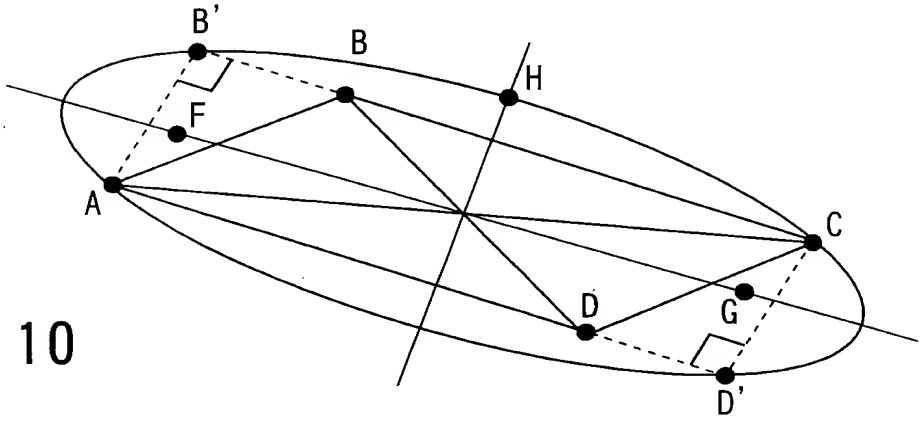


FIG. 10

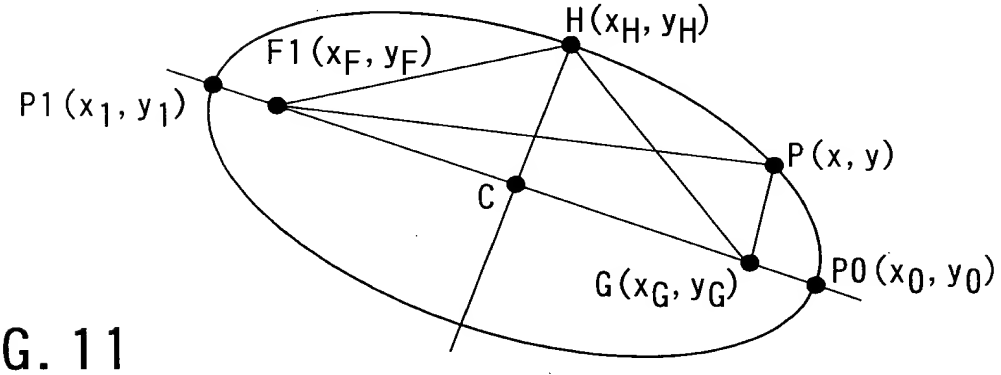


FIG. 11

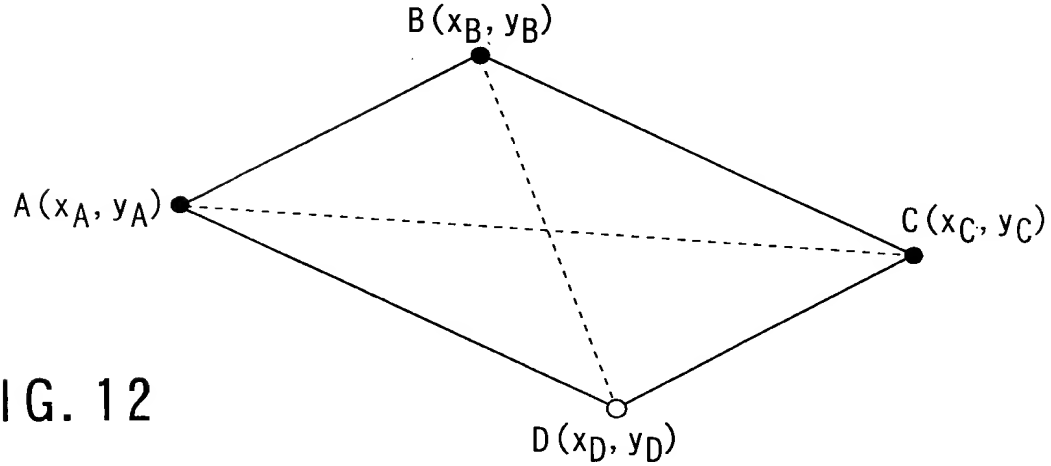


FIG. 12

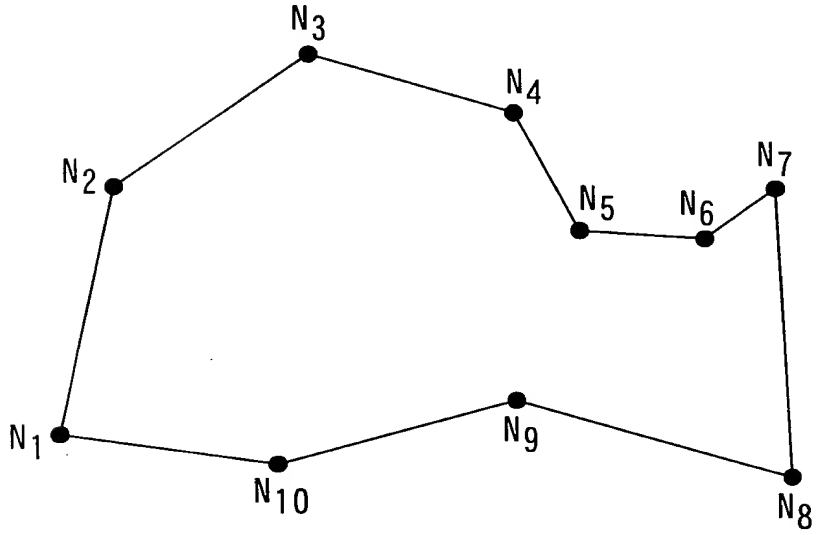


FIG. 13

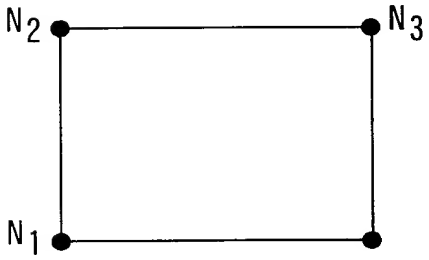


FIG. 14A

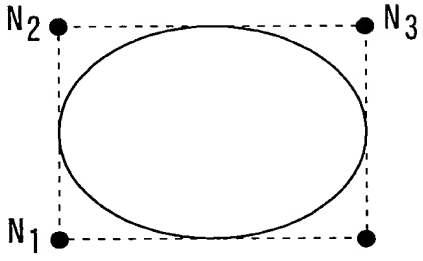


FIG. 14B

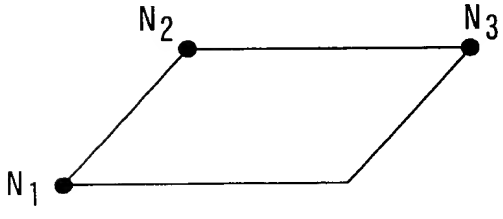


FIG. 14C

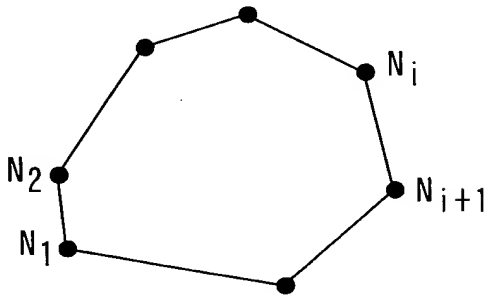


FIG. 14D

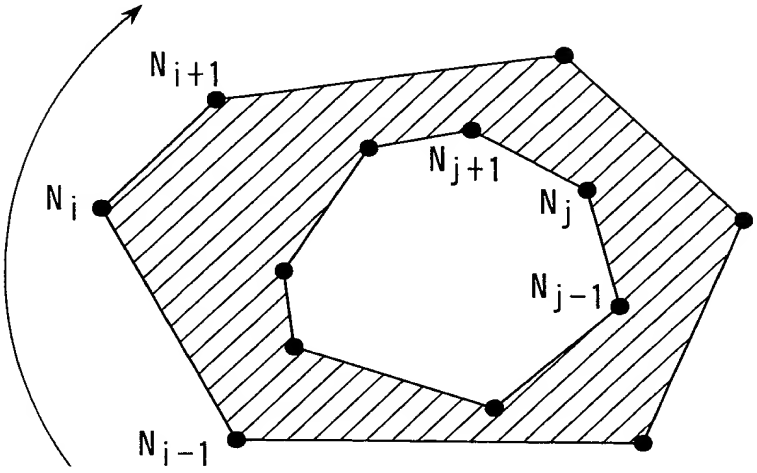


FIG. 15

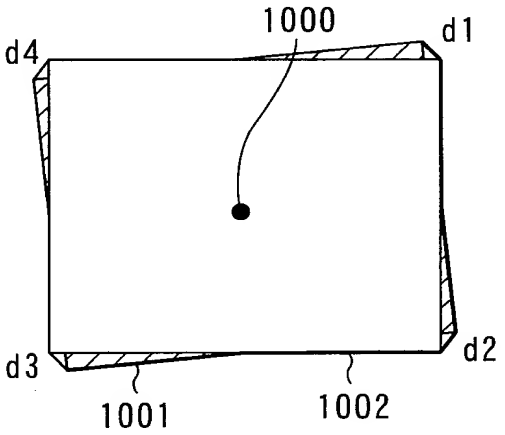


FIG. 16

MOVEMENT MODEL / APPROXIMATE FIGURE	ENLARGEMENT/REDUCTION	ROTATION	PARALLEL TRANSLATION	4-PARAMETER CONVERSION	AFFINE CONVERSION	PROJECTION CONVERSION	PARABOLIC CONVERSION
RECTANGLE, ELLIPSE (WITHOUT GRADIENT)	○	×	○	×	×	×	×
RECTANGLE, ELLIPSE (WITH GRADIENT)	○	○	○	○	×	×	×
PARALLELOGRAM	○	○	○	○	○	×	×
POLYGON (NUMBER OF VERTEXES >11)	○	○	○	○	○	○	○

FIG. 17

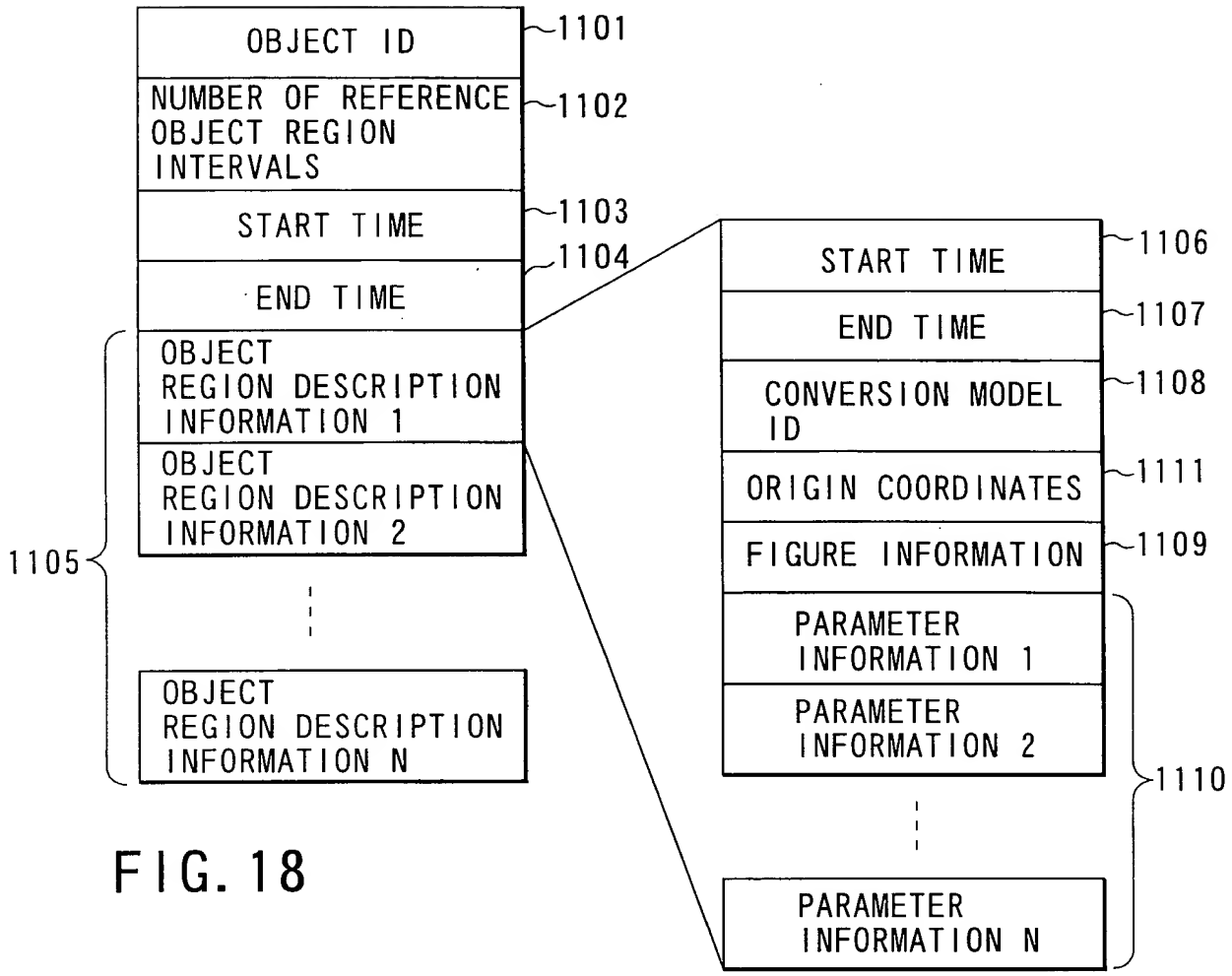

OBJECT ID
1101
NUMBER OF REFERENCE OBJECT REGION INTERVALS
1102
START TIME
1103
END TIME
1104
OBJECT REGION DESCRIPTION INFORMATION 1
OBJECT REGION DESCRIPTION INFORMATION 2
OBJECT REGION DESCRIPTION INFORMATION N
1105
START TIME
1106
END TIME
1107
CONVERSION MODEL ID
1108
ORIGIN COORDINATES
1111
FIGURE INFORMATION
1109
PARAMETER INFORMATION 1
PARAMETER INFORMATION 2
PARAMETER INFORMATION N
1110

FIG. 18

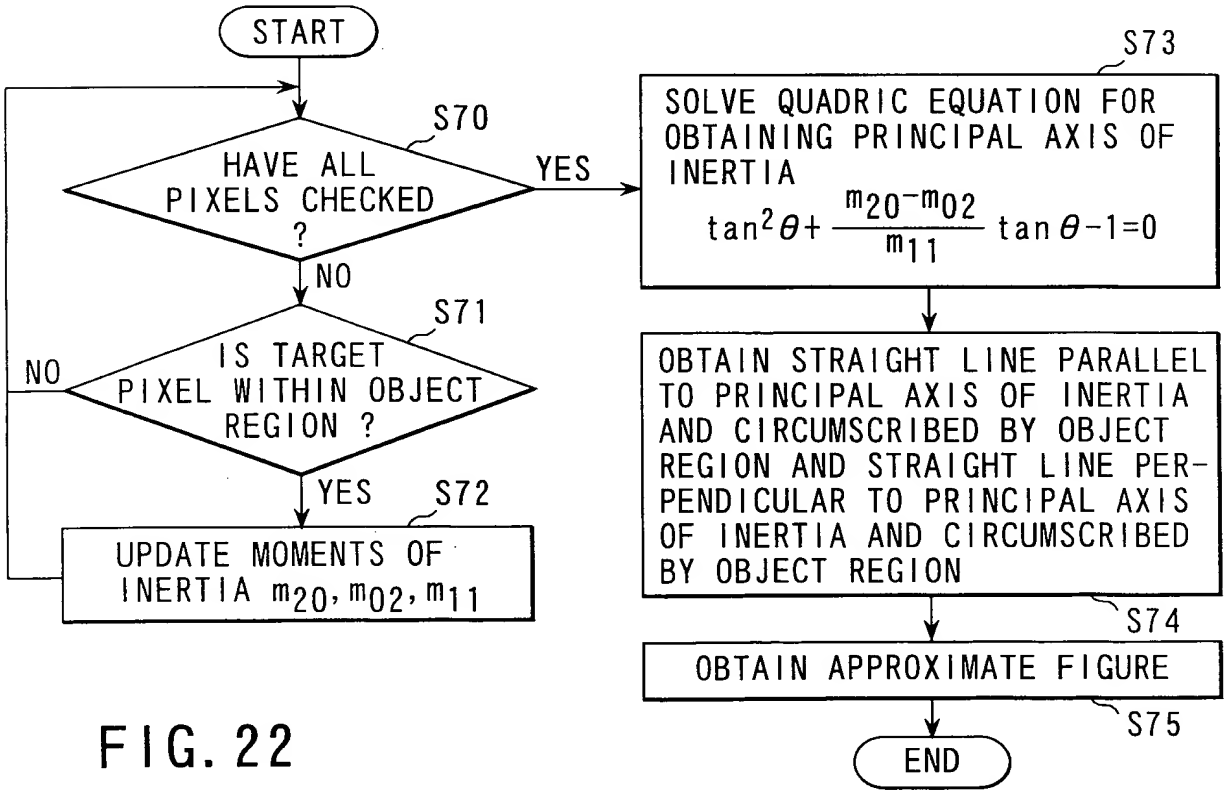

START
S70
HAVE ALL PIXELS CHECKED ?
YES
NO
S71
IS TARGET PIXEL WITHIN OBJECT REGION ?
NO
YES
S72
UPDATE MOMENTS OF INERTIA m_{20}, m_{02}, m_{11}
S73
SOLVE QUADRIC EQUATION FOR OBTAINING PRINCIPAL AXIS OF INERTIA
$\tan^2\theta + \frac{m_{20}-m_{02}}{m_{11}} \tan\theta - 1 = 0$
OBTAIN STRAIGHT LINE PARALLEL TO PRINCIPAL AXIS OF INERTIA AND CIRCUMSCRIBED BY OBJECT REGION AND STRAIGHT LINE PERPENDICULAR TO PRINCIPAL AXIS OF INERTIA AND CIRCUMSCRIBED BY OBJECT REGION
S74
OBTAIN APPROXIMATE FIGURE
S75
END

FIG. 22

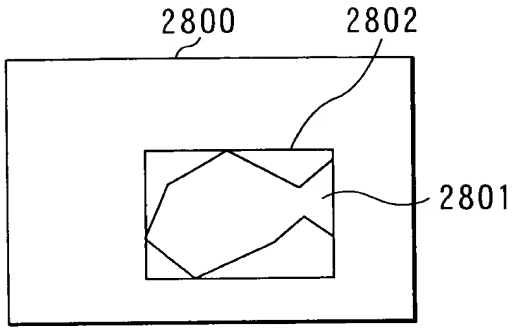


FIG. 19

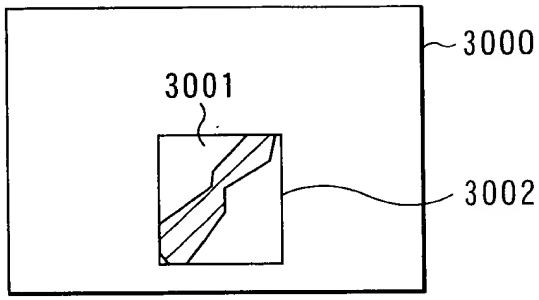


FIG. 20

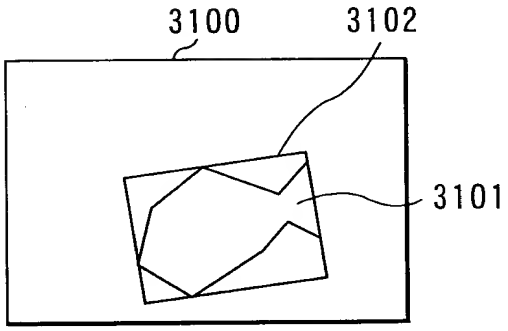


FIG. 21A

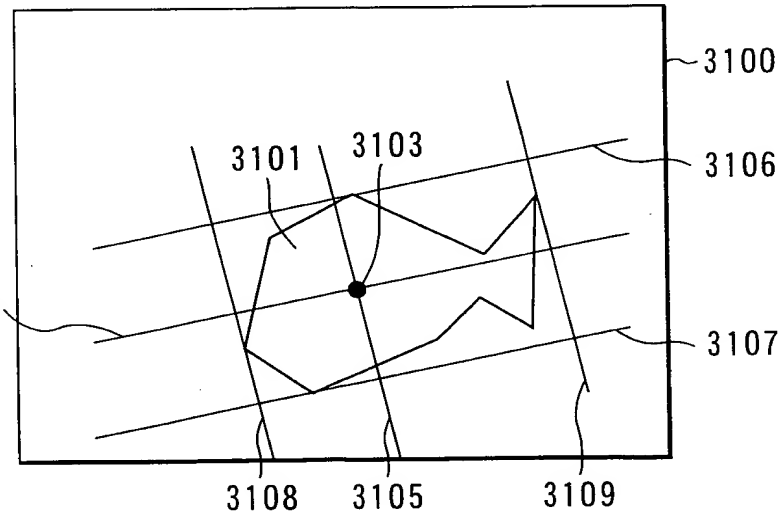


FIG. 21B

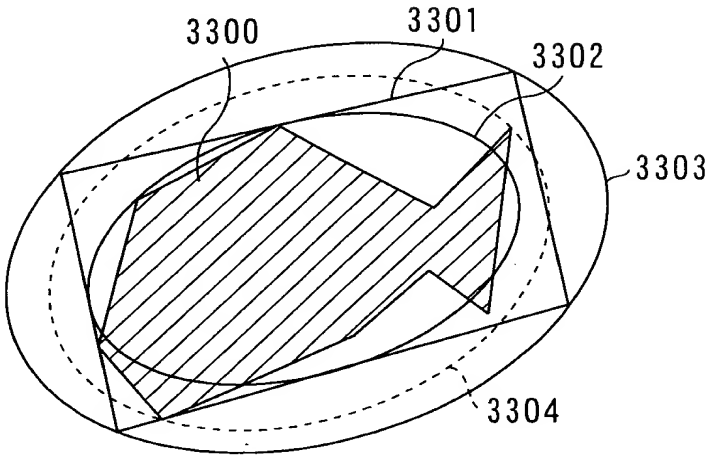


FIG. 23

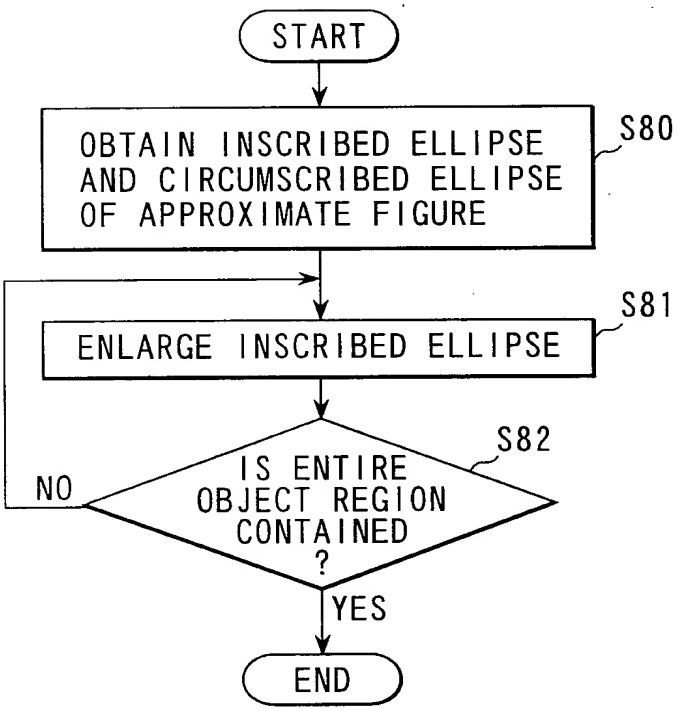


FIG. 24

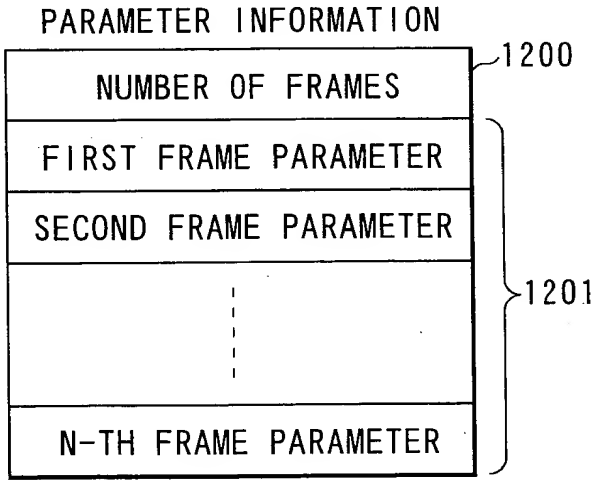


FIG. 25

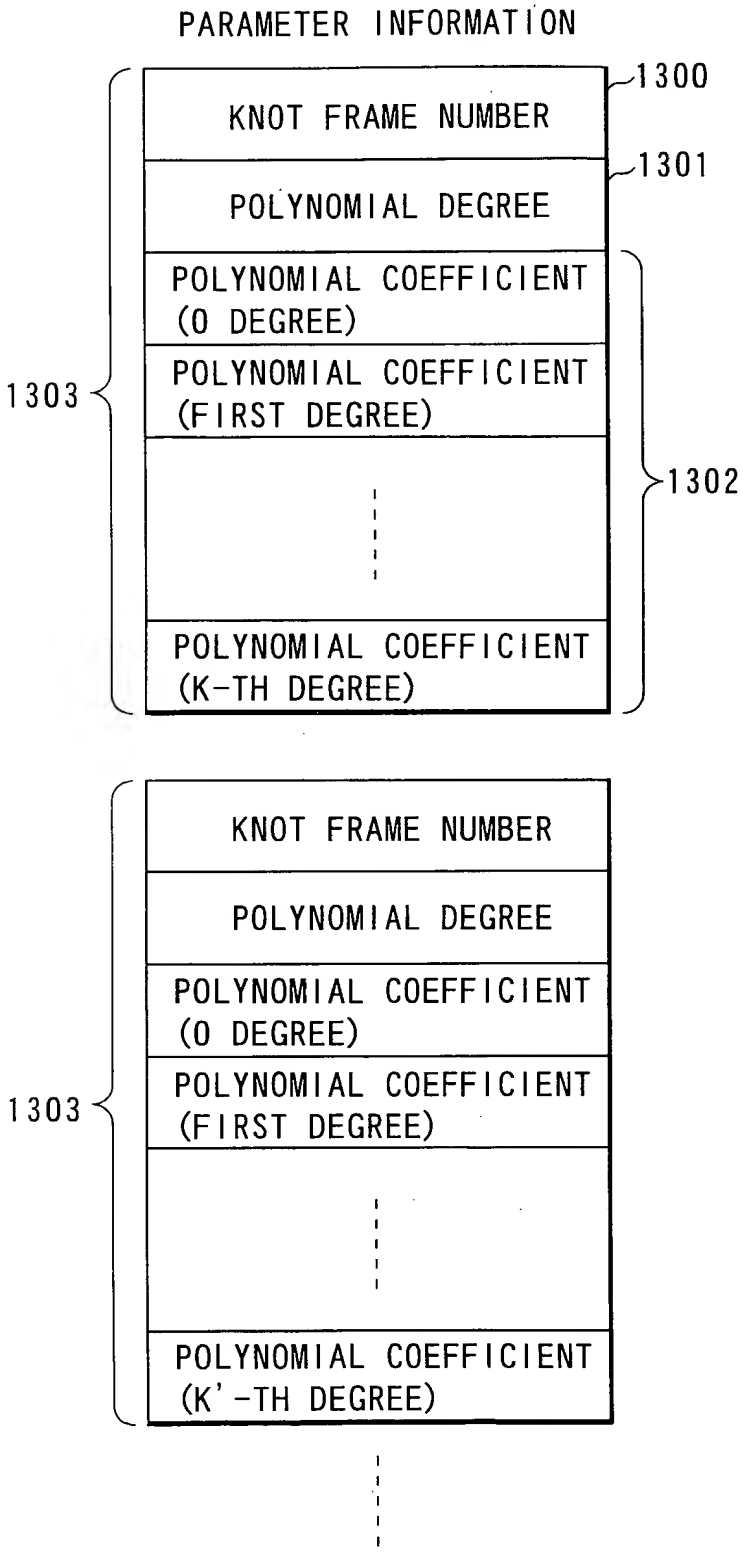

PARAMETER INFORMATION
KNOT FRAME NUMBER
1300
POLYNOMIAL DEGREE
1301
POLYNOMIAL COEFFICIENT (0 DEGREE)
POLYNOMIAL COEFFICIENT (FIRST DEGREE)
POLYNOMIAL COEFFICIENT (K-TH DEGREE)
1302
1303
KNOT FRAME NUMBER
POLYNOMIAL DEGREE
POLYNOMIAL COEFFICIENT (0 DEGREE)
POLYNOMIAL COEFFICIENT (FIRST DEGREE)
POLYNOMIAL COEFFICIENT (K'-TH DEGREE)
1303

FIG. 26

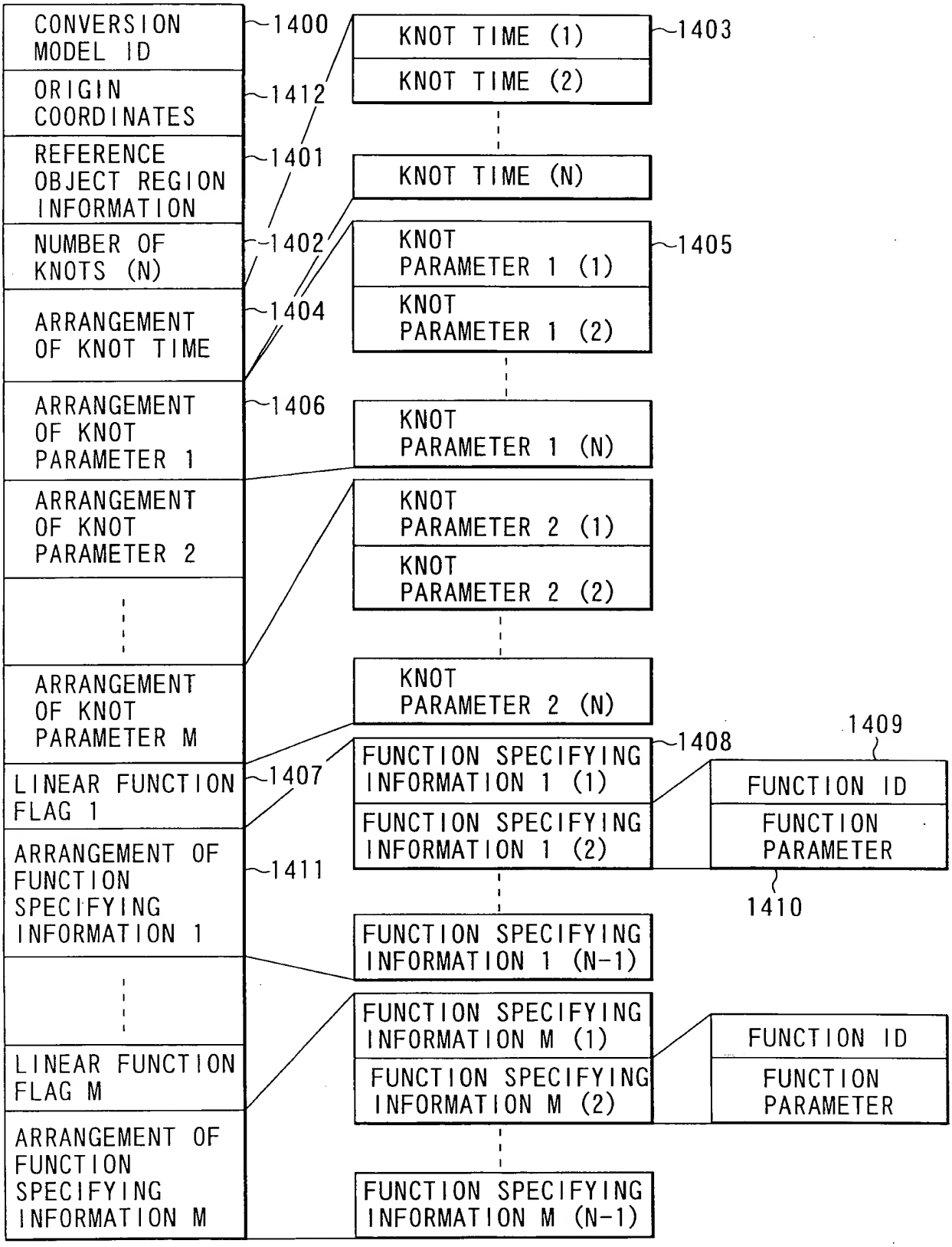

CONVERSION MODEL ID
1400
ORIGIN COORDINATES
1412
REFERENCE OBJECT REGION INFORMATION
1401
NUMBER OF KNOTS (N)
1402
ARRANGEMENT OF KNOT TIME
1404
ARRANGEMENT OF KNOT PARAMETER 1
1406
ARRANGEMENT OF KNOT PARAMETER 2
ARRANGEMENT OF KNOT PARAMETER M
LINEAR FUNCTION FLAG 1
1407
ARRANGEMENT OF FUNCTION SPECIFYING INFORMATION 1
1411
LINEAR FUNCTION FLAG M
ARRANGEMENT OF FUNCTION SPECIFYING INFORMATION M
KNOT TIME (1)
KNOT TIME (2)
KNOT TIME (N)
1403
KNOT PARAMETER 1 (1)
KNOT PARAMETER 1 (2)
KNOT PARAMETER 1 (N)
1405
KNOT PARAMETER 2 (1)
KNOT PARAMETER 2 (2)
KNOT PARAMETER 2 (N)
FUNCTION SPECIFYING INFORMATION 1 (1)
FUNCTION SPECIFYING INFORMATION 1 (2)
1408
FUNCTION SPECIFYING INFORMATION 1 (N-1)
FUNCTION SPECIFYING INFORMATION M (1)
FUNCTION SPECIFYING INFORMATION M (2)
FUNCTION SPECIFYING INFORMATION M (N-1)
1409
FUNCTION ID
FUNCTION PARAMETER
1410
FUNCTION ID
FUNCTION PARAMETER

FIG. 27

FUNCTION ID	TYPE OF FUNCTION	FUNCTION PARAMETER	LIMIT CONDITION
-1	NO TYPE(NUMBER IS NOT DEFINED)	NO PARAMETER	NO LIMIT
0	$f(t)=f_a+\nu_a(t-t_a)$	NO PARAMETER	$\nu_a=\frac{f_b-f_a}{t_b-t_a}$
1	$f(t)=f_a+\nu_a(t-t_a)+\frac{1}{2}a_a(t-t_a)^2$	a_a	$\nu_a=\frac{f_b-f_a}{t_b-t_a}-\frac{1}{2}a_a(t_b-t_a)$

FIG. 28

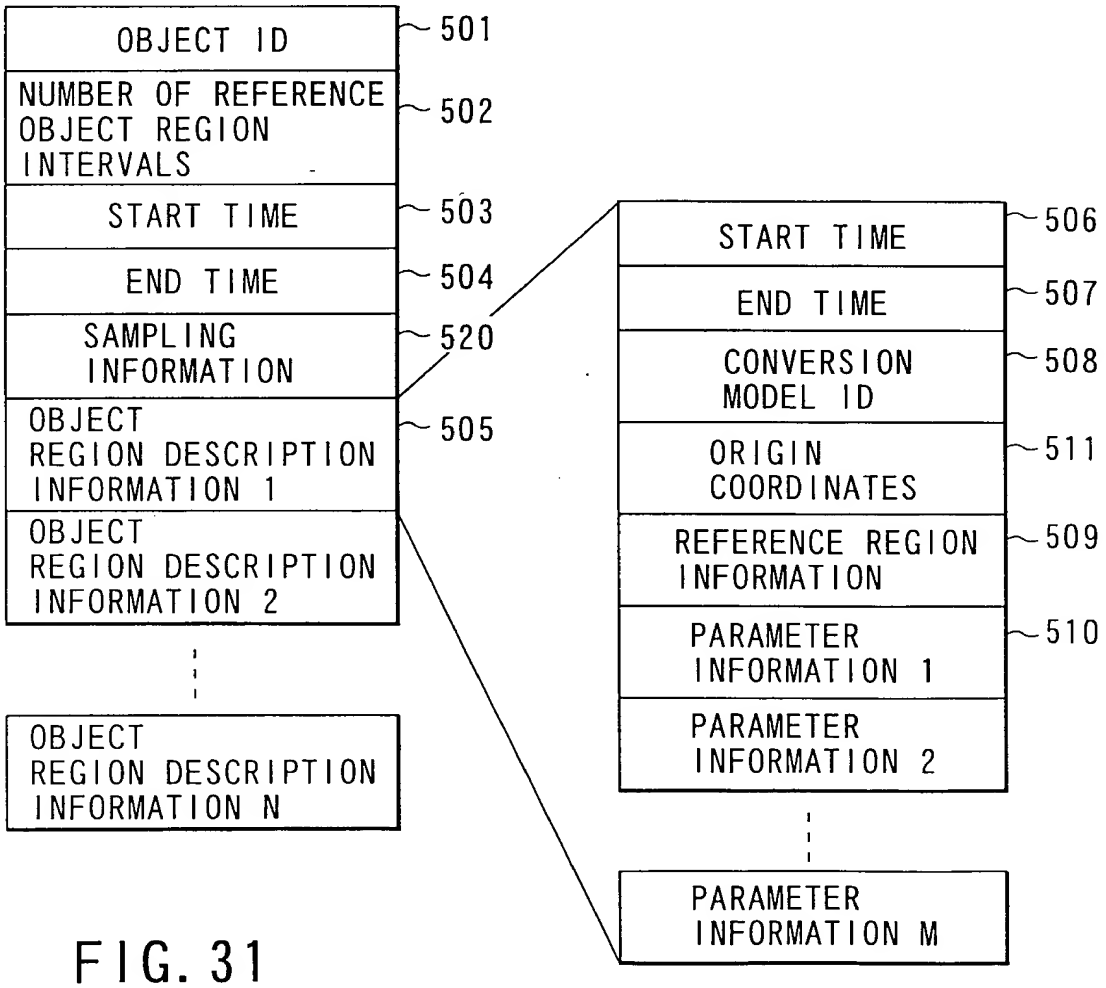


FIG. 31

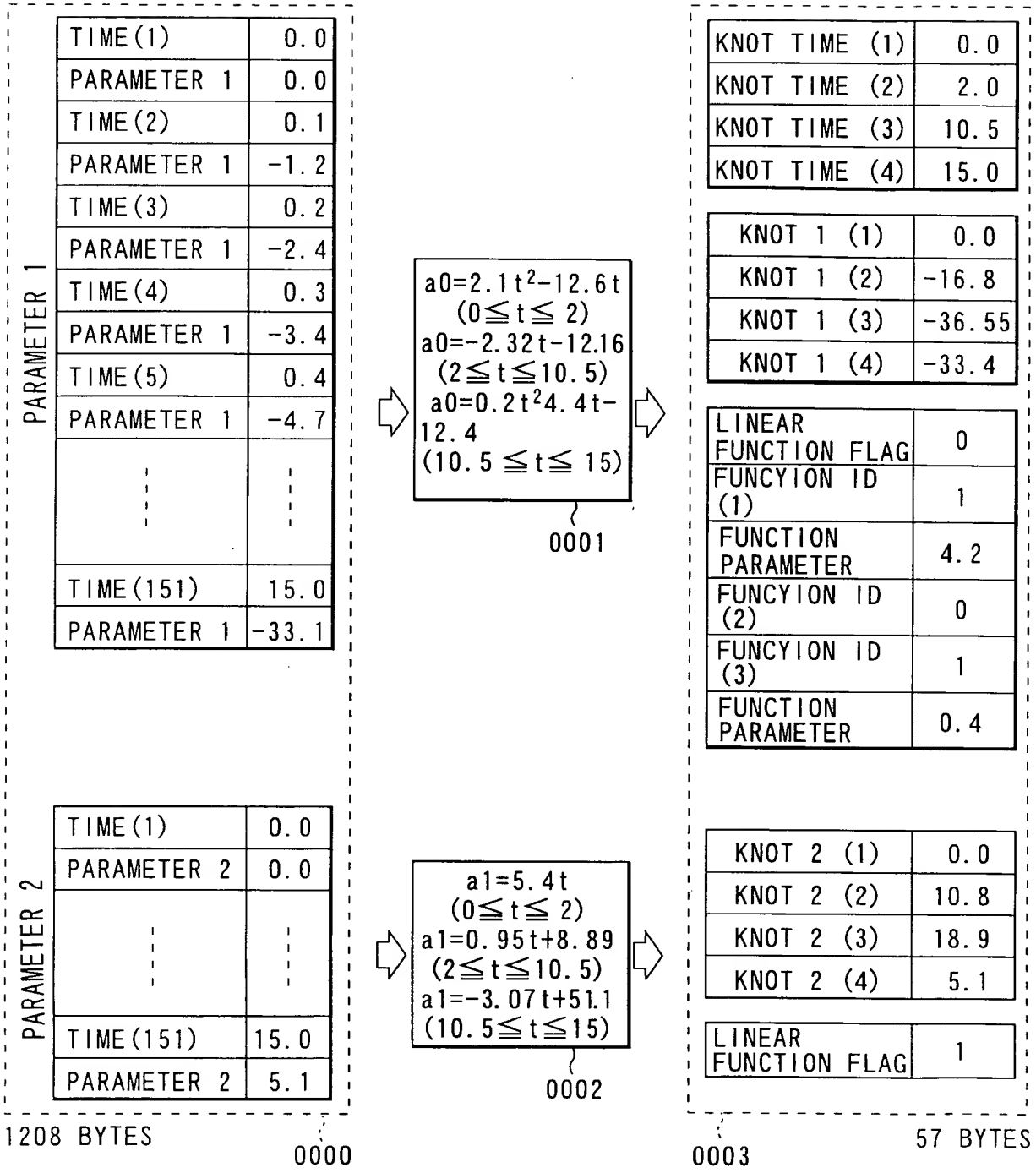

PARAMETER 1
TIME(1) 0.0
PARAMETER 1 0.0
TIME(2) 0.1
PARAMETER 1 -1.2
TIME(3) 0.2
PARAMETER 1 -2.4
TIME(4) 0.3
PARAMETER 1 -3.4
TIME(5) 0.4
PARAMETER 1 -4.7
TIME(151) 15.0
PARAMETER 1 -33.1
PARAMETER 2
TIME(1) 0.0
PARAMETER 2 0.0
TIME(151) 15.0
PARAMETER 2 5.1
1208 BYTES
0000
a0=2.1t²-12.6t (0≦t≦2)
a0=-2.32t-12.16 (2≦t≦10.5)
a0=0.2t²4.4t-12.4 (10.5≦t≦15)
0001
a1=5.4t (0≦t≦2)
a1=0.95t+8.89 (2≦t≦10.5)
a1=-3.07t+51.1 (10.5≦t≦15)
0002
KNOT TIME (1) 0.0
KNOT TIME (2) 2.0
KNOT TIME (3) 10.5
KNOT TIME (4) 15.0
KNOT 1 (1) 0.0
KNOT 1 (2) -16.8
KNOT 1 (3) -36.55
KNOT 1 (4) -33.4
LINEAR FUNCTION FLAG 0
FUNCYION ID (1) 1
FUNCTION PARAMETER 4.2
FUNCYION ID (2) 0
FUNCYION ID (3) 1
FUNCTION PARAMETER 0.4
KNOT 2 (1) 0.0
KNOT 2 (2) 10.8
KNOT 2 (3) 18.9
KNOT 2 (4) 5.1
LINEAR FUNCTION FLAG 1
0003
57 BYTES

FIG. 29

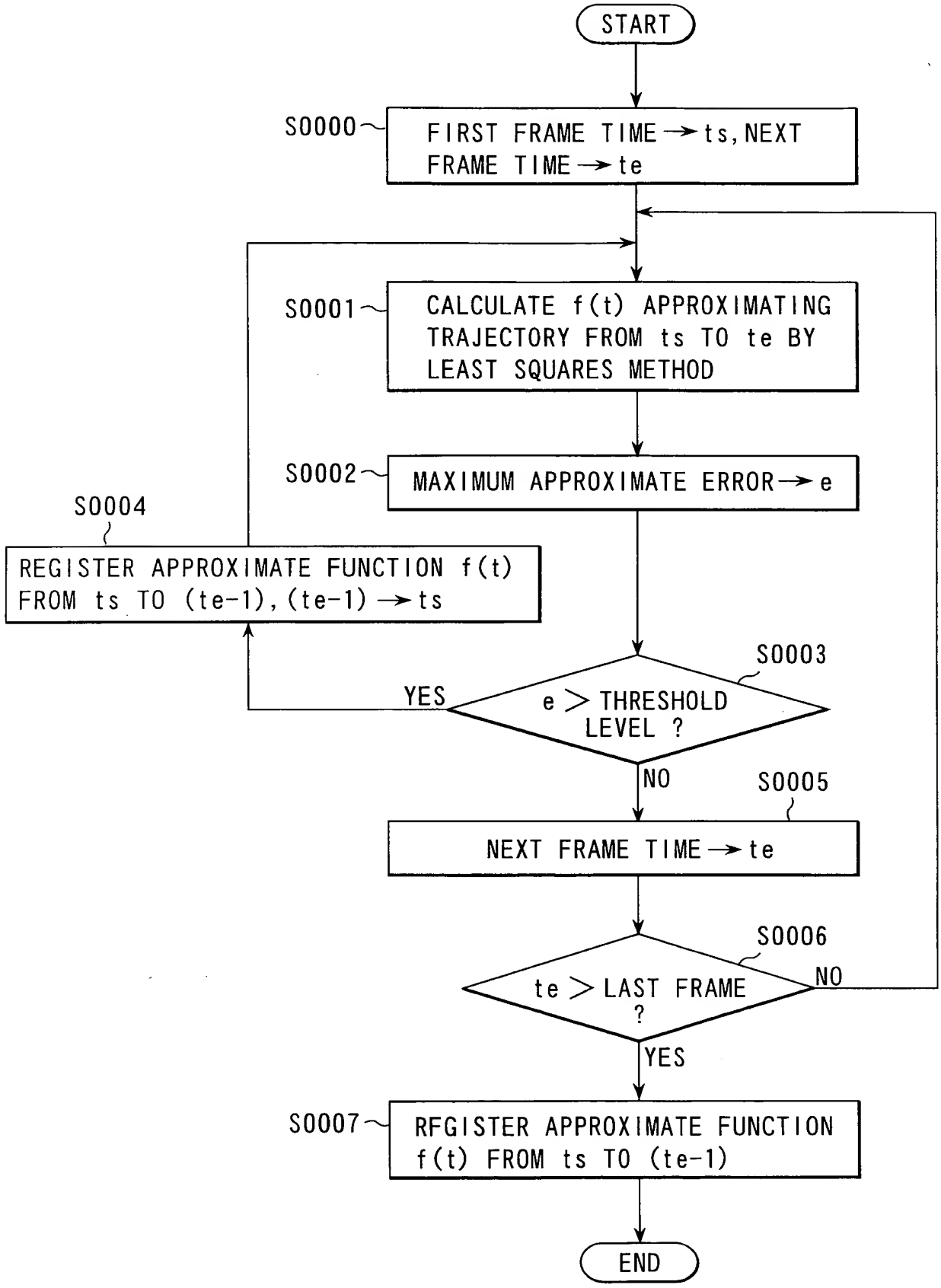

START
S0000
FIRST FRAME TIME → ts, NEXT FRAME TIME → te
S0001
CALCULATE f(t) APPROXIMATING TRAJECTORY FROM ts TO te BY LEAST SQUARES METHOD
S0002
MAXIMUM APPROXIMATE ERROR → e
S0003
e > THRESHOLD LEVEL ?
YES
S0004
REGISTER APPROXIMATE FUNCTION f(t) FROM ts TO (te-1), (te-1) → ts
NO
S0005
NEXT FRAME TIME → te
S0006
te > LAST FRAME ?
NO
YES
S0007
RFGISTER APPROXIMATE FUNCTION f(t) FROM ts TO (te-1)
END

FIG. 30

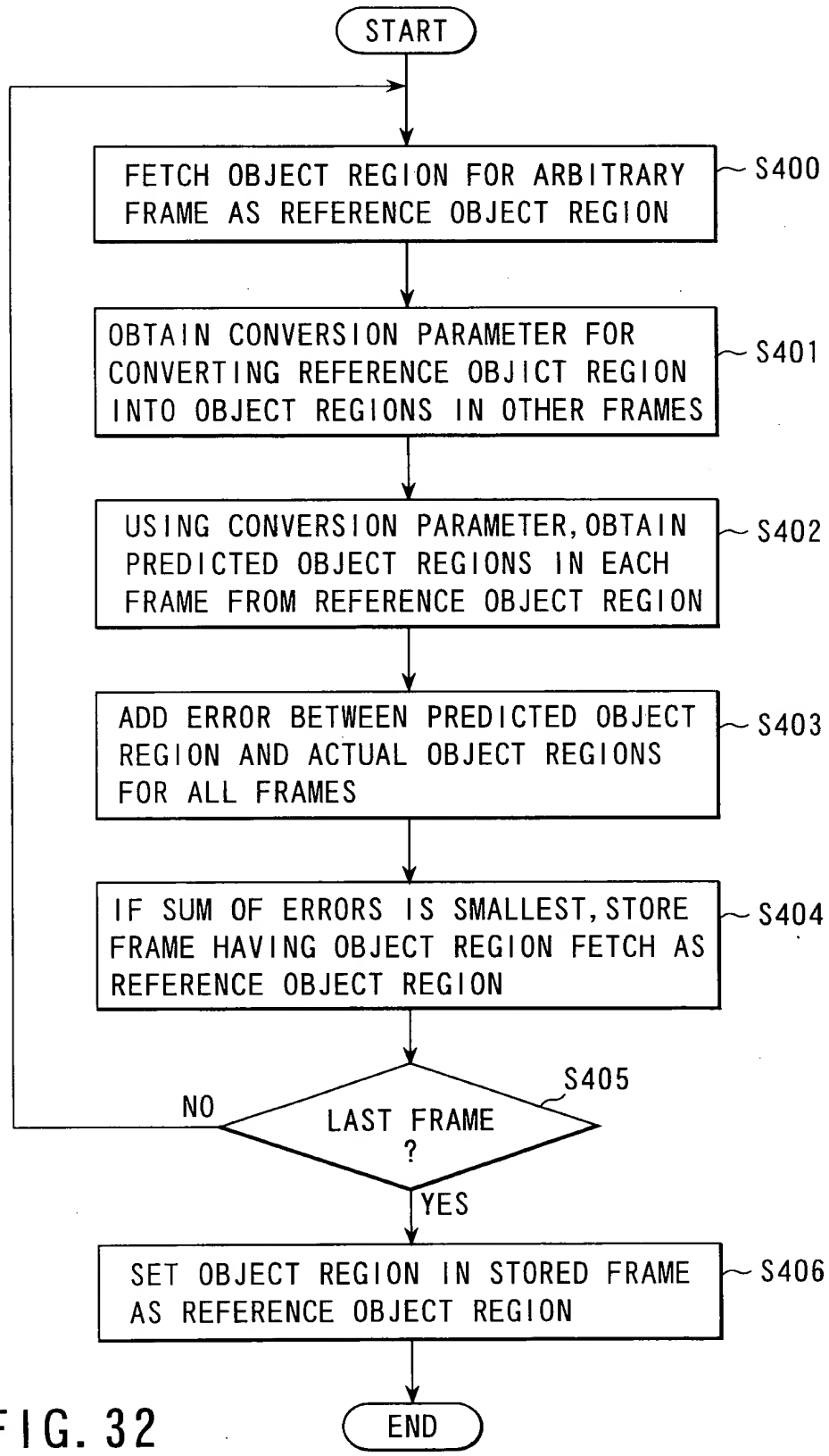

START
FETCH OBJECT REGION FOR ARBITRARY FRAME AS REFERENCE OBJECT REGION
S400
OBTAIN CONVERSION PARAMETER FOR CONVERTING REFERENCE OBJICT REGION INTO OBJECT REGIONS IN OTHER FRAMES
S401
USING CONVERSION PARAMETER, OBTAIN PREDICTED OBJECT REGIONS IN EACH FRAME FROM REFERENCE OBJECT REGION
S402
ADD ERROR BETWEEN PREDICTED OBJECT REGION AND ACTUAL OBJECT REGIONS FOR ALL FRAMES
S403
IF SUM OF ERRORS IS SMALLEST, STORE FRAME HAVING OBJECT REGION FETCH AS REFERENCE OBJECT REGION
S404
S405
NO
LAST FRAME ?
YES
SET OBJECT REGION IN STORED FRAME AS REFERENCE OBJECT REGION
S406
END

FIG. 32

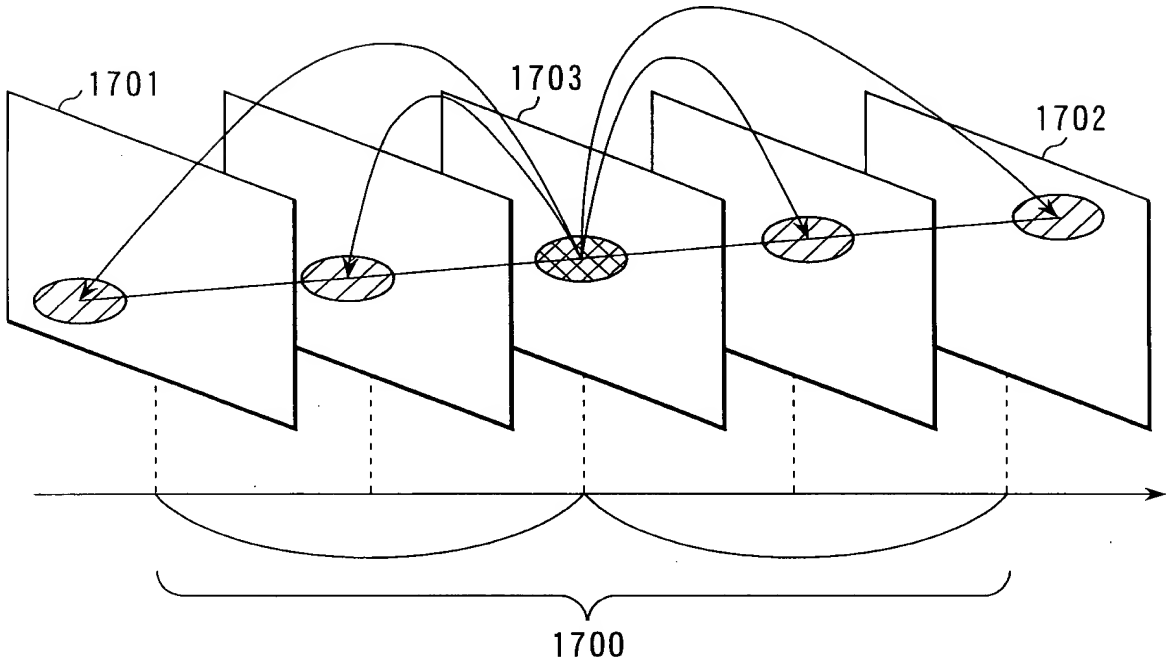


FIG. 33

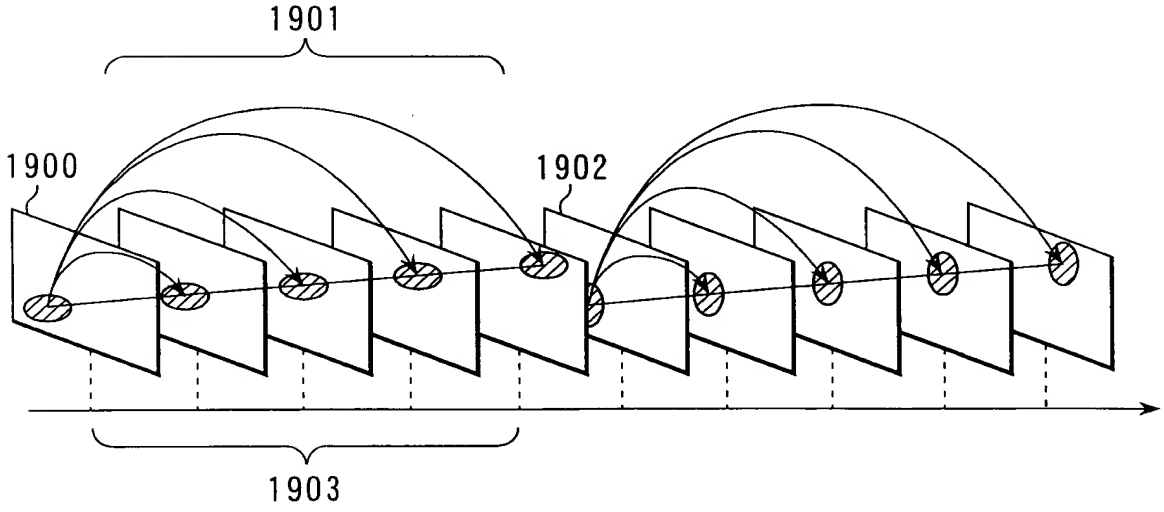


FIG. 35

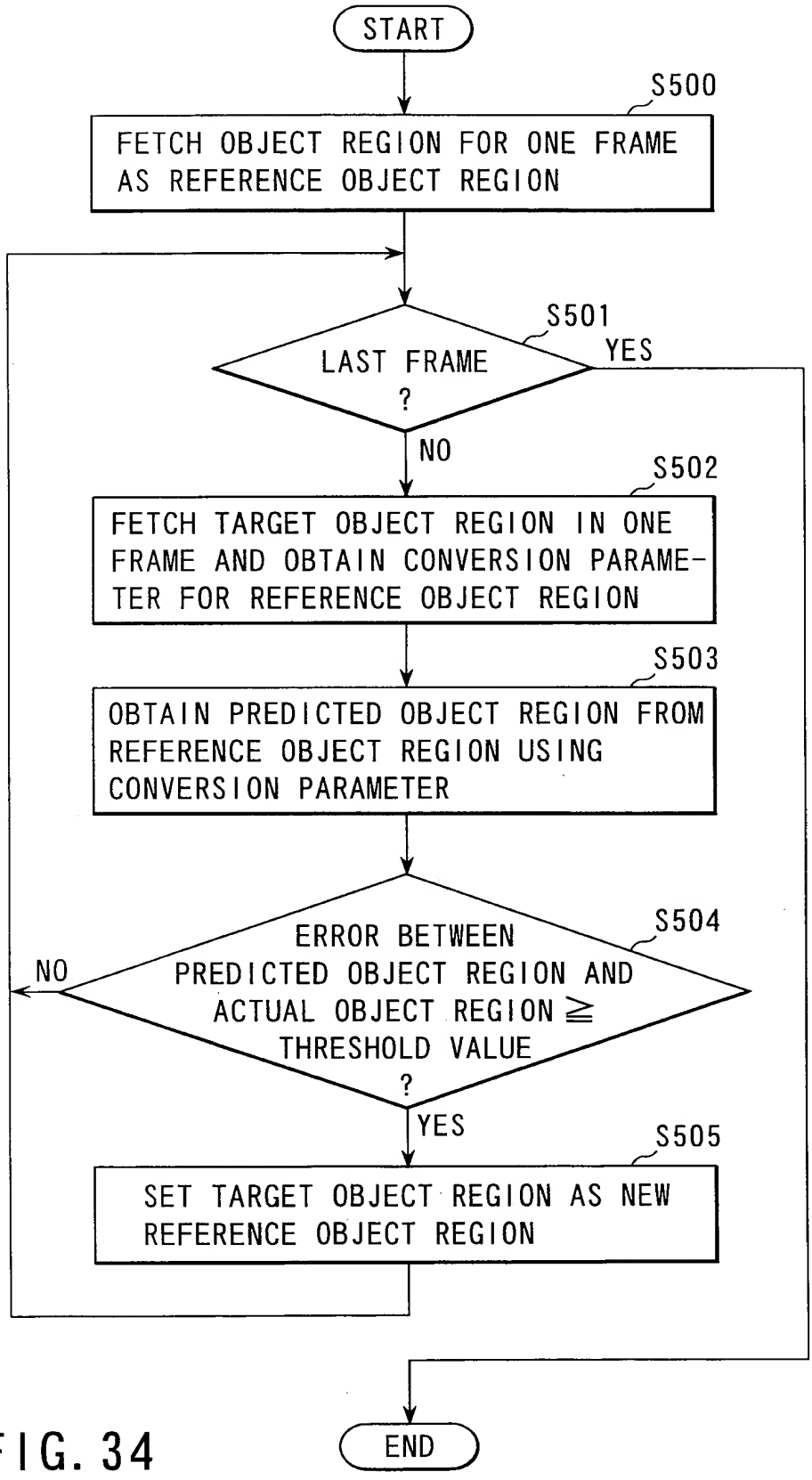

START
S500
FETCH OBJECT REGION FOR ONE FRAME AS REFERENCE OBJECT REGION
S501
LAST FRAME ?
YES
NO
S502
FETCH TARGET OBJECT REGION IN ONE FRAME AND OBTAIN CONVERSION PARAMETER FOR REFERENCE OBJECT REGION
S503
OBTAIN PREDICTED OBJECT REGION FROM REFERENCE OBJECT REGION USING CONVERSION PARAMETER
S504
ERROR BETWEEN PREDICTED OBJECT REGION AND ACTUAL OBJECT REGION ≧ THRESHOLD VALUE ?
NO
YES
S505
SET TARGET OBJECT REGION AS NEW REFERENCE OBJECT REGION
END

FIG. 34

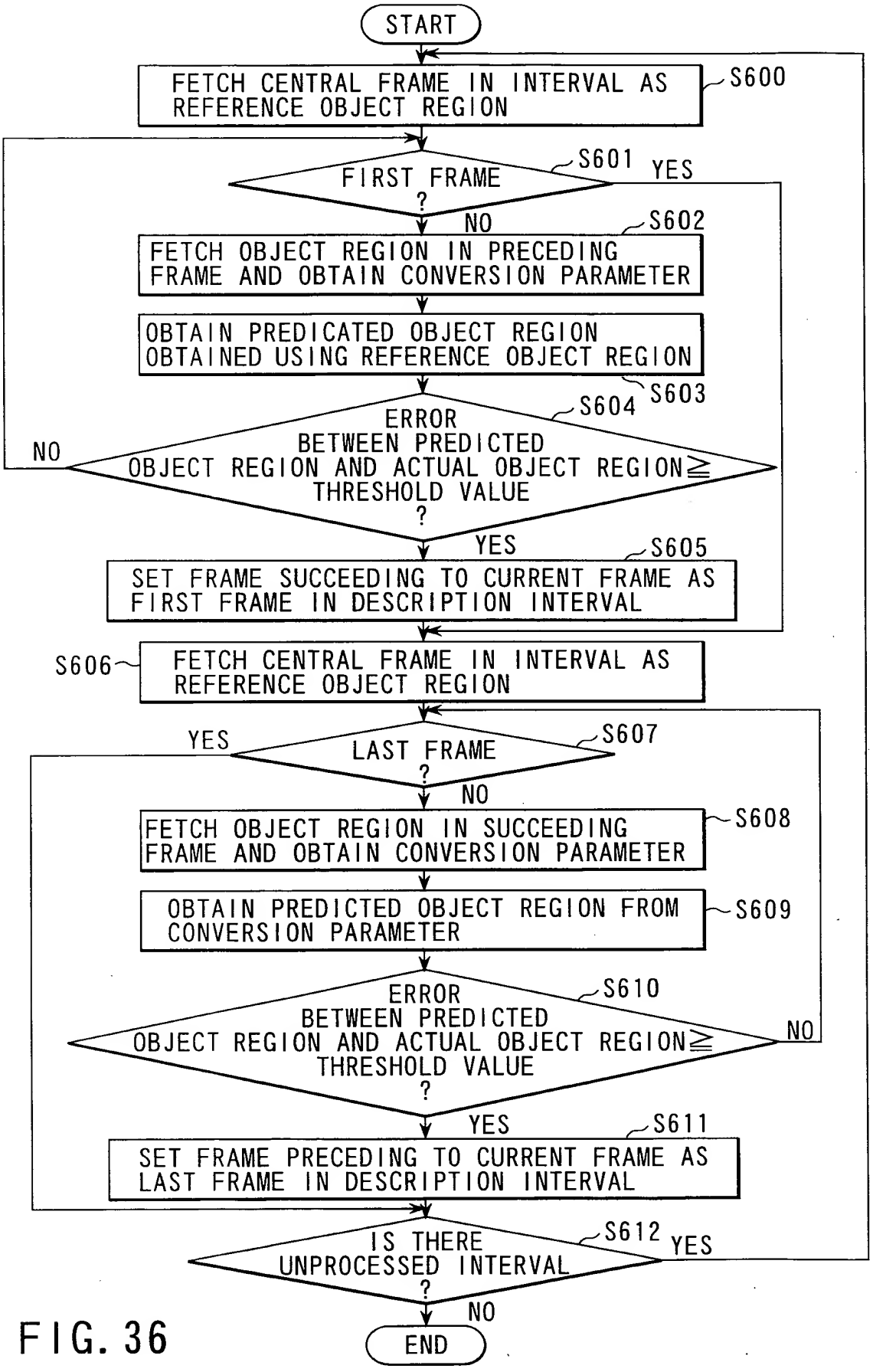

START
FETCH CENTRAL FRAME IN INTERVAL AS REFERENCE OBJECT REGION
S600
FIRST FRAME ?
S601
YES
NO
FETCH OBJECT REGION IN PRECEDING FRAME AND OBTAIN CONVERSION PARAMETER
S602
OBTAIN PREDICATED OBJECT REGION OBTAINED USING REFERENCE OBJECT REGION
S603
ERROR BETWEEN PREDICTED OBJECT REGION AND ACTUAL OBJECT REGION≧ THRESHOLD VALUE ?
S604
NO
YES
SET FRAME SUCCEEDING TO CURRENT FRAME AS FIRST FRAME IN DESCRIPTION INTERVAL
S605
FETCH CENTRAL FRAME IN INTERVAL AS REFERENCE OBJECT REGION
S606
LAST FRAME ?
S607
YES
NO
FETCH OBJECT REGION IN SUCCEEDING FRAME AND OBTAIN CONVERSION PARAMETER
S608
OBTAIN PREDICTED OBJECT REGION FROM CONVERSION PARAMETER
S609
ERROR BETWEEN PREDICTED OBJECT REGION AND ACTUAL OBJECT REGION≧ THRESHOLD VALUE ?
S610
NO
YES
SET FRAME PRECEDING TO CURRENT FRAME AS LAST FRAME IN DESCRIPTION INTERVAL
S611
IS THERE UNPROCESSED INTERVAL ?
S612
YES
NO
END

FIG. 36

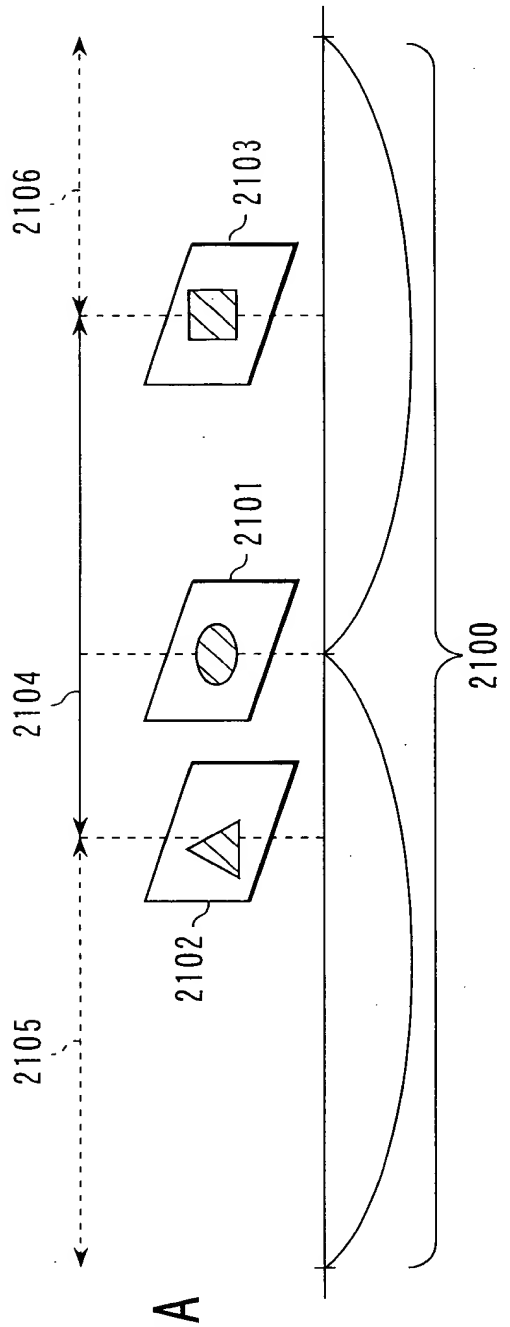


FIG. 37A

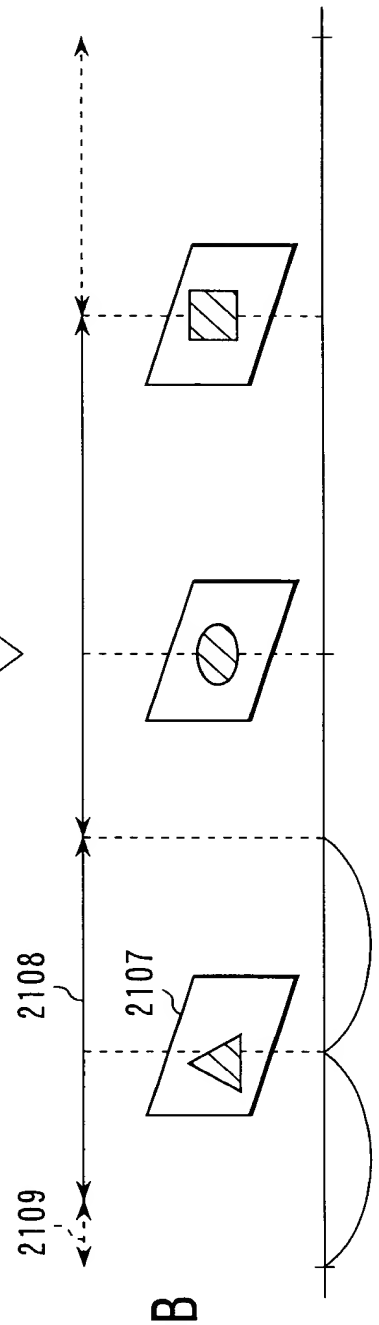
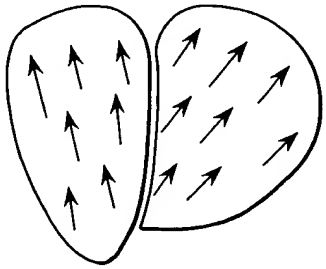


FIG. 37B

FIG. 38



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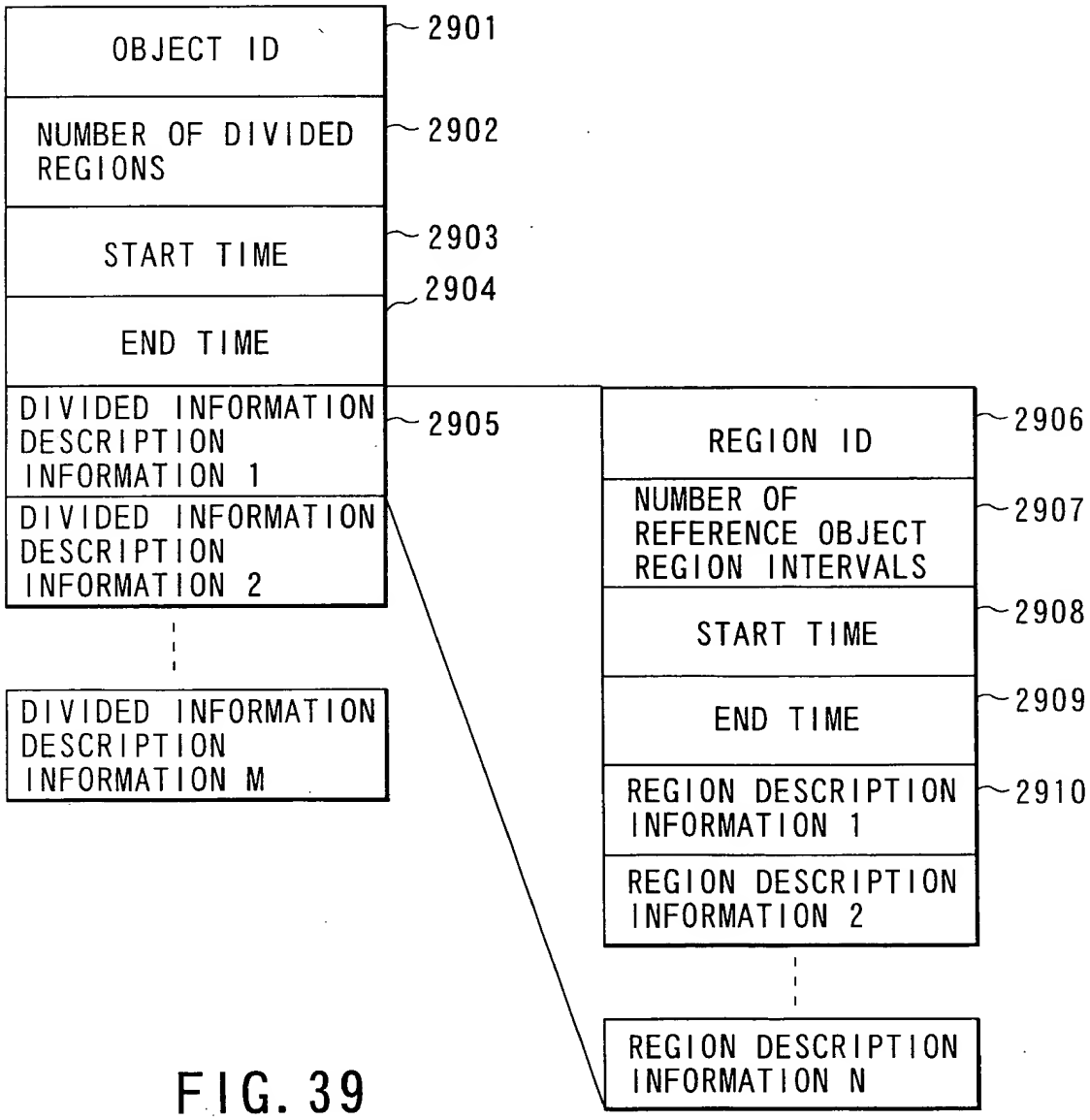

FIG. 39

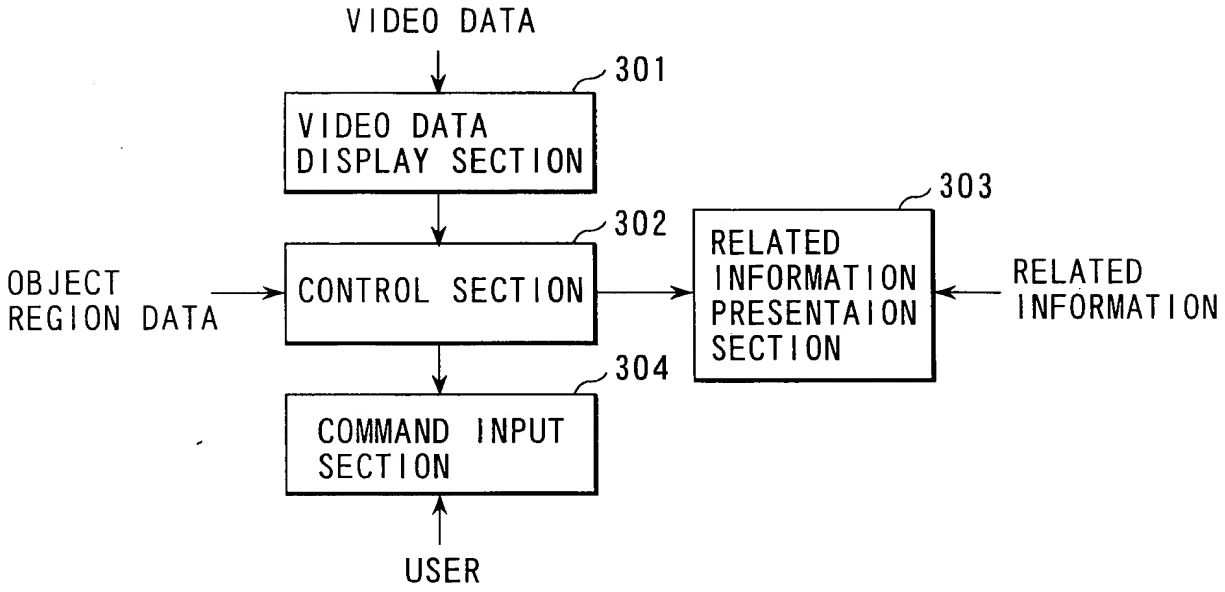
VIDEO DATA
301
VIDEO DATA DISPLAY SECTION
302
CONTROL SECTION
303
RELATED INFORMATION PRESENTAION SECTION
OBJECT REGION DATA
RELATED INFORMATION
304
COMMAND INPUT SECTION
USER

FIG. 40

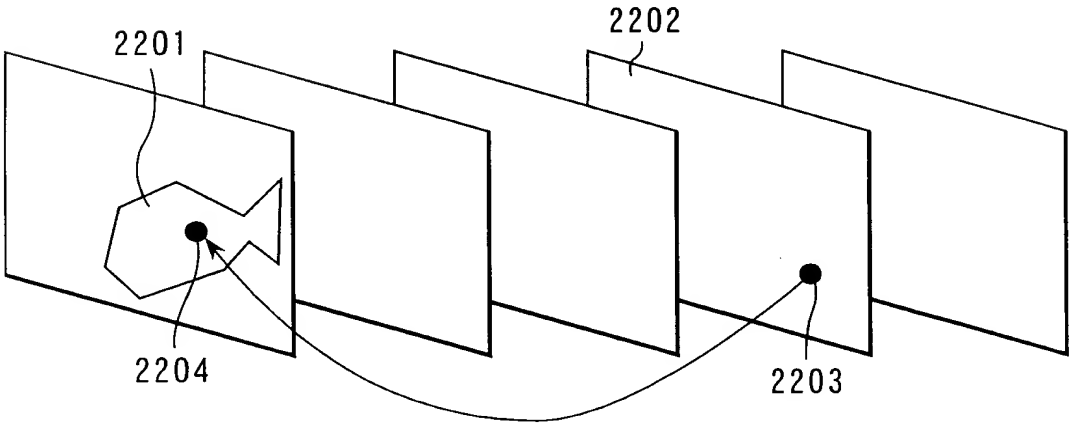
2201
2202
2204
2203

FIG. 41

DOCKET # 19547 US SHEET 24 OF 28
OBLON ET AL (703) 413-3000

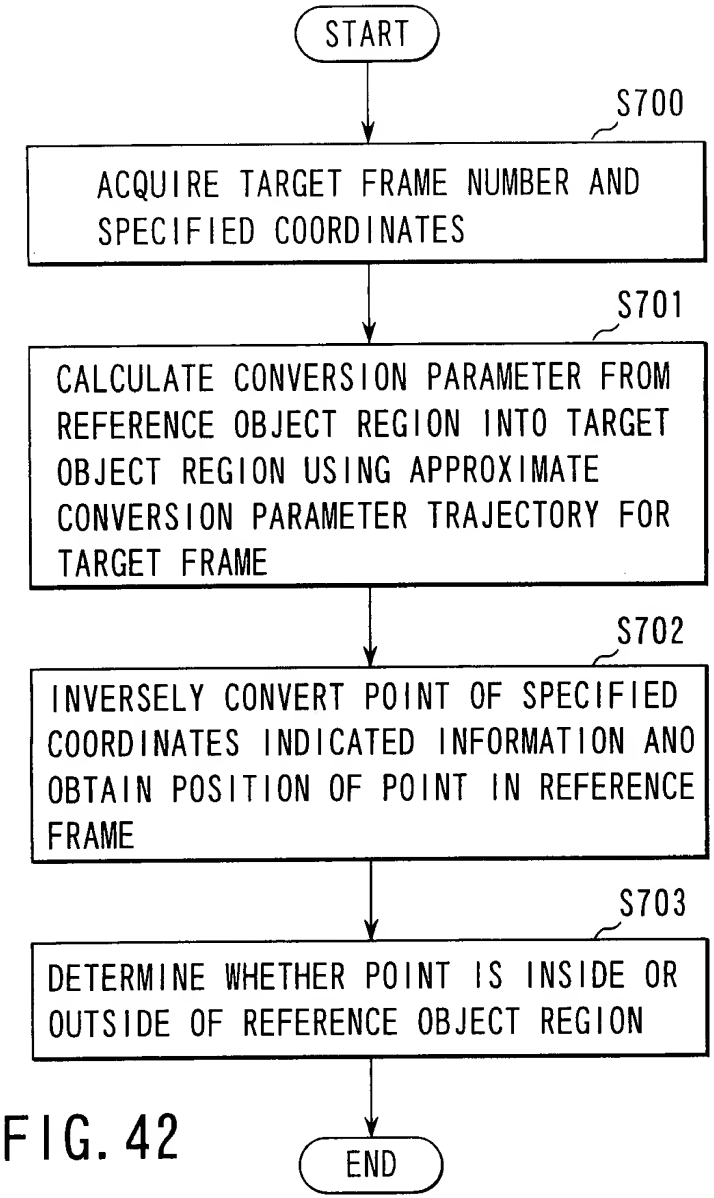

FIG. 42

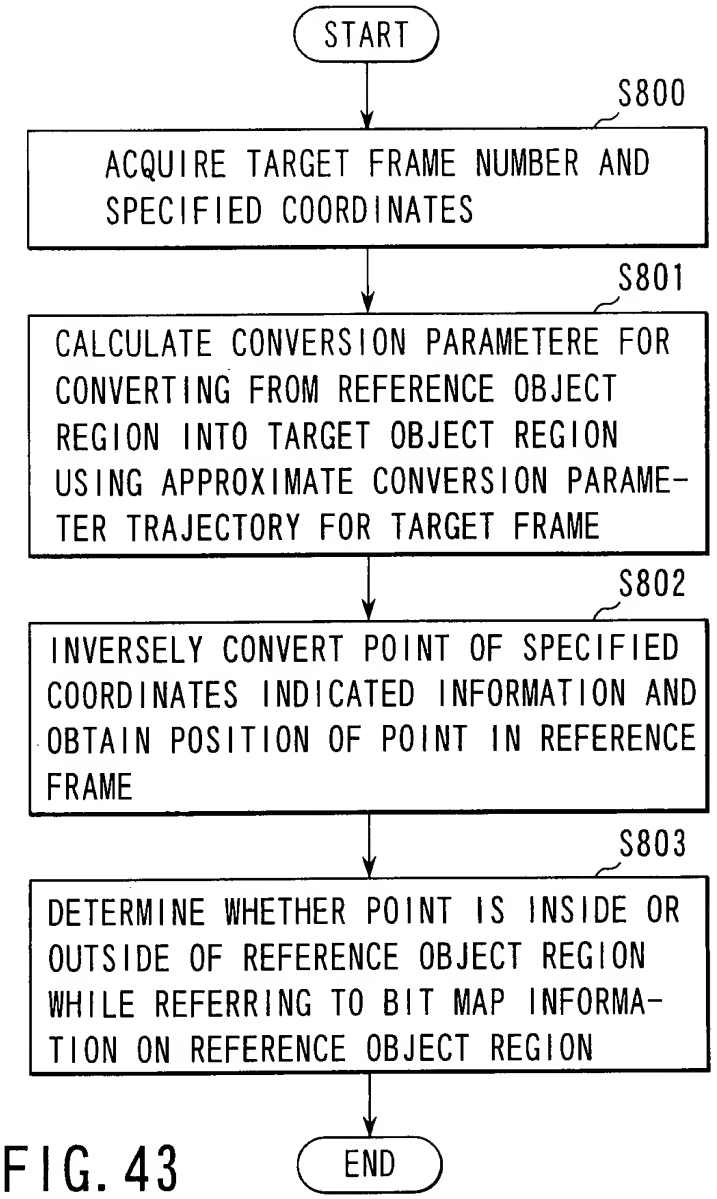

FIG. 43

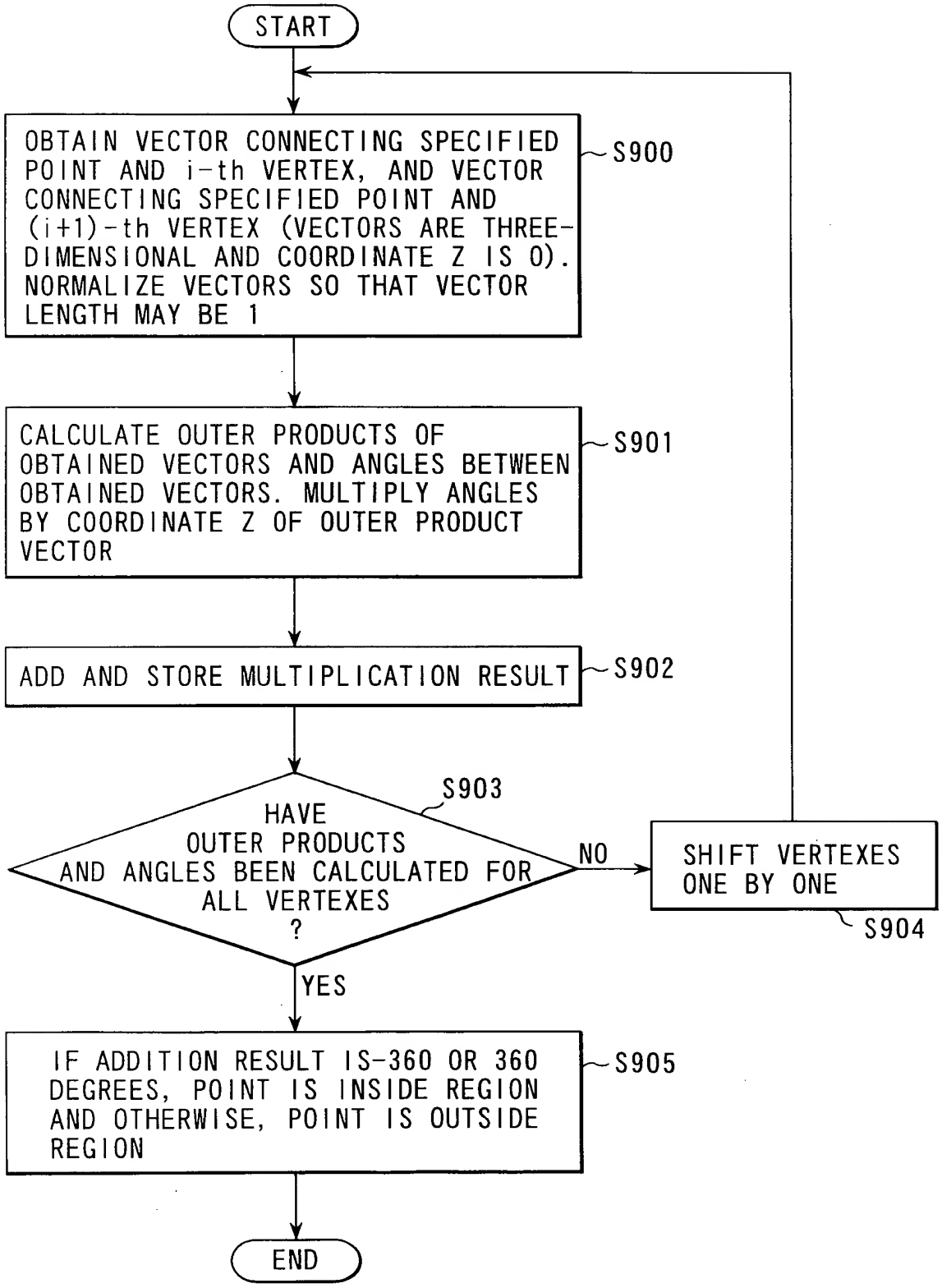
START
OBTAIN VECTOR CONNECTING SPECIFIED POINT AND i-th VERTEX, AND VECTOR CONNECTING SPECIFIED POINT AND (i+1)-th VERTEX (VECTORS ARE THREE-DIMENSIONAL AND COORDINATE Z IS 0). NORMALIZE VECTORS SO THAT VECTOR LENGTH MAY BE 1
S900
CALCULATE OUTER PRODUCTS OF OBTAINED VECTORS AND ANGLES BETWEEN OBTAINED VECTORS. MULTIPLY ANGLES BY COORDINATE Z OF OUTER PRODUCT VECTOR
S901
ADD AND STORE MULTIPLICATION RESULT
S902
S903
HAVE OUTER PRODUCTS AND ANGLES BEEN CALCULATED FOR ALL VERTEXES ?
NO
SHIFT VERTEXES ONE BY ONE
S904
YES
IF ADDITION RESULT IS-360 OR 360 DEGREES, POINT IS INSIDE REGION AND OTHERWISE, POINT IS OUTSIDE REGION
S905
END

FIG. 44

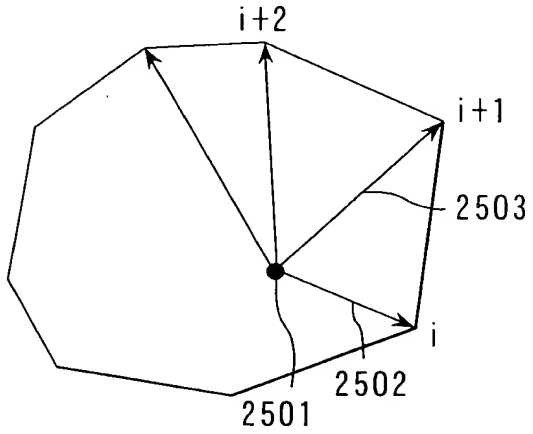

FIG. 45

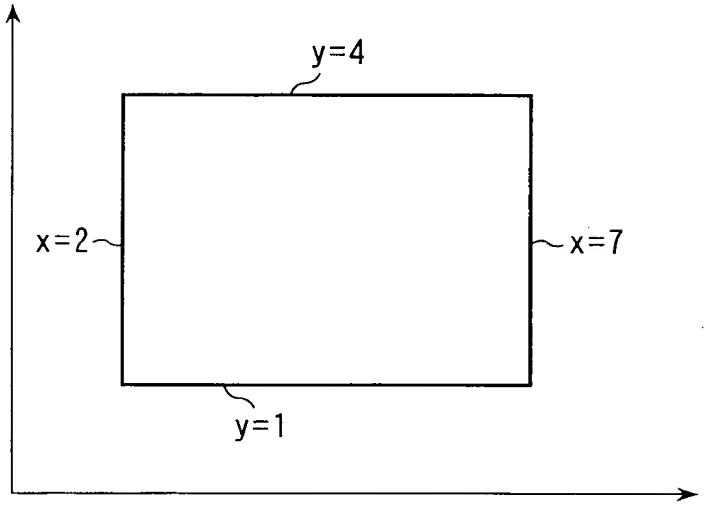

FIG. 46

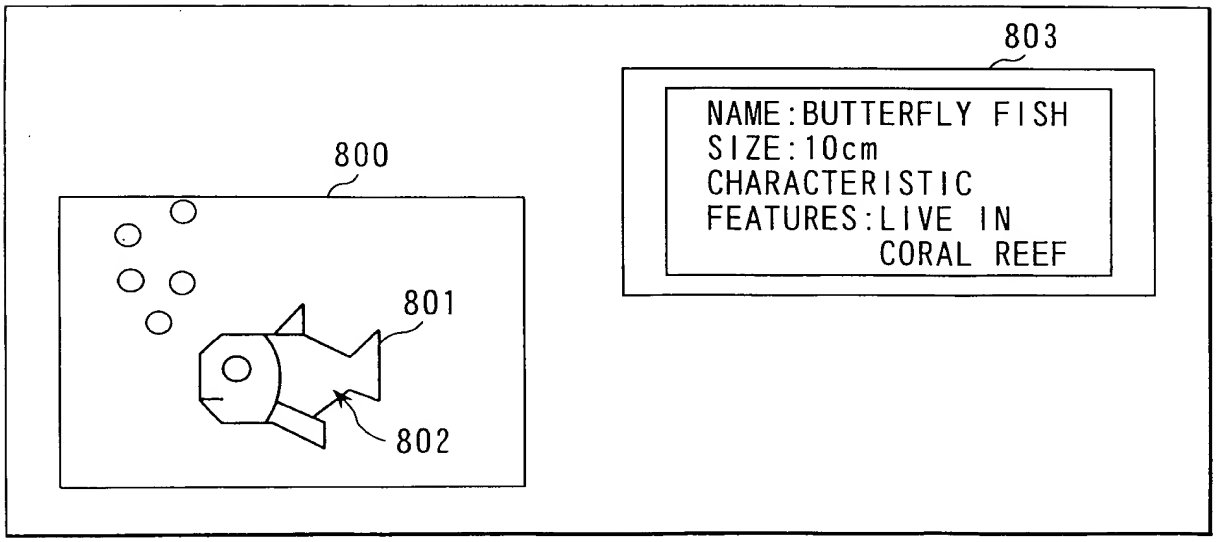

FIG. 47